SCIENCE

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GALILEO, THE PHYSICIST[1]

THE mission of an academy of science is a function of the age in which it flourishes. The ancient academies accomplished a work now performed by the universities. The Italian academies of the Renaissance, variously estimated at from 500 to 700 in number, represent different purposes almost as numerous as the institutions themselves. But in general they were literary and scientific clans; they belonged to a period when learning was the possession of the few, to a period when one might still take all science for his domain.

The modern academy is, as a rule, closely allied with the sovereign power of some state, whose interests are promoted by it, consciously and unconsciously, in a variety of ways. The service which it renders is sometimes political, sometimes literary, sometimes scientific, sometimes social. But, so far as I can see, they all have, in common, these two ends, namely, the encouragement of the individual and service to the community.

The triple purpose of the Illinois State Academy of Science is clearly stated in the second article of its constitution as being "the promotion of scientific research, the diffusion of scientific knowledge and of the scientific spirit, and the unification of the scientific interests of the state"; just how this object can best be secured is the interesting subject of an after-dinner discussion this evening.

I leave this problem, therefore, with the

[1] Presidential address, delivered before the Illinois Academy of Science, at Peoria, February 21, 1913.

single remark that the importance of cultivating individual initiative and of handing on to the community the best there is in the achievements of science is not likely to be overestimated.

Symonds[2] points out that Athens and Florence owed their wonderful intellectual, artistic and literary success mainly to the fact that they nourished the individuality of their citizens; while Sparta and Venice, comparatively barren of permanent results, illustrate the lack of such encouragement.

I now invite your attention to one of the earliest members of the venerable and thankworthy Academy of the Lyncei, a man who represents in the highest degree the individuality then cultivated in Tuscany, a man whose impress upon his students was so deep that shortly after his death they united to form one of the most productive and justly celebrated of all the Italian academies,[3] a man whose written works fill twenty splendid quarto volumes,[4] a man who in his efforts to put before the people the best science of his times, endured opposition, criticism, disgrace and social ostracism throughout most of his thinking life. I refer to Galileo. But I shall speak only of what he did in physics, because I believe this phase of his work is too little known.

What Galileo saw through telescopes of his own make, though not of his own invention, is so familiar that possibly a majority of intelligent men think of him mainly as an astronomer. The spots on the sun, the mountains on the moon, the satellites of Jupiter, the phases of Venus, the "triple character" of Saturn, the solar rotation period, lunar libration and earthshine are some of the celestial phenomena associated with the name of Galileo. These and his brilliant defense of the Copernican system are responsible for the impression that his accomplishments are chiefly astronomical.

To another large group of men he stands mainly for liberty, intellectual, social and religious. These men classify him with Giordano Bruno and De Dominis and Campanella who also had some experience with the cardinals of the Inquisition. For them Galileo is the man who dared to differ with Aristotle, the man who brushed aside the mists of philosophy, the man who banished church traditions from his thinking while he calmly pursued his search after unity in the physical universe.[5] It is doubtless his splendid stand for spiritual freedom which leads Goethe[6] in his historical sketch of optics to say:

> Even though he never seriously studied the subject of color, I must at least adorn my page with his name.

But there is still a third group of men to whom the great Italian appeals most strongly because he has given them a new method of working and thinking, a new viewpoint, a new *aperçu*. To put this contribution in its proper perspective is not an easy matter; we are too near it and too familiar with it. If, however, one considers the time interval between Archimedes and Kelvin he can not fail to notice a sharp discontinuity in the progress of physics occurring about the beginning of the sev-

[2] "Renaissance in Italy," Vol. I., p. 234.

[3] *Accademia del Cimento*, founded in 1657; disbanded in 1667.

[4] Edited by the scholarly care of Professor Favaro, of the University of Padua, and published by the Italian government, 1890–1909. Referred to hereafter as "Nat. Ed."

[5] For a masterly presentation of this phase of Galileo's work, see Dr. Charles T. Little's article in the *Methodist Review*, Vol. 88, pp. 204–218, 1906.

[6] Goethe, "Farben-lehre Historische Theil," art. Galileo.

enteenth century. Just how commerce and industry led up to, and prepared the way for, this step is the subject of a most interesting chapter by a member of this academy, Professor Mann.[7]

Without underestimating the contributions of Pappus or Tartaglia or Benedetti or Stevinus or Leonardo da Vinci, to mechanics; and without denying the important rôle of statics in architecture and in other structural work, one may, I believe, fairly say that the years which intervene between Archimedes and Galileo are practically barren of progress in physics.

It is true, indeed, that during this interval a large number of isolated physical facts had been discovered; indeed, there is scarcely a chapter in physics in which some advance of this type can not be mentioned; but, during all this while, nothing in the way of development is seen; individual discoveries remain isolated; they do not bear fruit; speculation and guessing were still employed where we use observation and measurement and computation. Leonardo da Vinci likens a scientific conquest to a military victory in which theory is the field marshal; experimental facts, the soldiers. The philosophers who preceded Galileo had, in the main, been trying to fight battles without soldiers. The only possible exceptions to this statement are Roger Bacon, Leonardo da Vinci, Stevinus and Gilbert. They had measured some mechanical quantities—a few of them—masses and stresses—such as could be obtained by means of a steel-yard and a measuring stick; but they were still in the domain of statics. Now from a geometrical, esthetic or even utilitarian standpoint it is difficult to imagine any finer subject than graphical statics; and yet when we regard the progress of physics, statics is to dynamics somewhat as osteology is to physiology, a veritable valley of dry bones. The live part of mechanics is kinetics, the study of masses which are in motion, the consideration of bodies which are changing their velocities, currents of water, oscillating magnets, vibrating strings, rotating wheels, electric motors, heat engines, electromagnetic waves, and X-rays. These are the problems over which men lose sleep; these are the questions which compel the interest of the physicist; these are the subjects whose mastery confers power upon the engineer. The one confessed aim of physical science is, indeed, to describe the motion of bodies in the simplest possible manner. Indeed, it is only by the aid of this modern science of the energy of motion that any of the ancient mechanical doctrines—such as the atomic theory of Democritus—have acquired validity; it is this same science which has rendered the heliocentric theory of Copernicus not merely "a plausible view" but the one possible view.

We pass now to a more definite question, namely, what contribution did "our Academician" make to the solution of problems of this type, to the science which now goes by the name of physics? To answer briefly and baldly, he instituted the method and set into motion the machinery by which practically all these problems have been solved, in so far as they have been solved at all. But lest I give the false impression that Galileo was the ancestor of all the physical sciences, I hasten to a more detailed answer of the query, What did Galileo?

1. First, no greater mistake could be made than to suppose that Galileo was the first man to differ with Aristotle; the academy of Cosenza, having opposition to the peripatetic philosophy as its avowed purpose, was established at Naples about

[7] Mann, "Teaching of Physics," pp. 107–110 (Macmillan, 1912).

the time when Galileo was born; but he *was* the first man to offer *experimental evidence* against the conclusions of Aristotle; and in so doing he established what we now call the experimental method. He was not handing on an opinion which some "dusty-minded professor" had inherited from an ancestor of the same type.

Only two methods of investigation were known to the ancients, the philosophical and the mathematical; to these Galileo added a third, the experimental. The philosophical method consisted in assuming certain general principles and trying to find in them an *a priori* explanation of the universe. Briefly described, the attempt was to stare nature out of countenance. Failure was inevitable, not for want of intellectual acumen, but because, as every one in this assembly knows, it sometimes requires a lifetime of effort to explain a single detail. Witness almost any chapter in Darwin's "Origin of Species." Details must be mastered before one can pass to general principles.

The mathematical method consisted only in applying geometry to certain well-known areas, volumes and angles, especially to those angles observed in the sky, but always with the idea of describing the known rather than of discovering the unknown: the mathematicians do not appear to have put any deliberate questions to nature; or as Rowland said:

> A mathematical investigation always obeys the law of the conservation of knowledge: we never get out more from it than we put in. The knowledge may be changed in form, it may be clearer and more exactly stated; but the total amount of the knowledge of nature given out by the investigation is the same as we started with.

The experimental method, established mainly by Galileo, not only combines the observations of the philosophers with the measurements of the mathematicians, but adds deliberate experiment with a distinct purpose to interrogate nature concerning some detail of her behavior. Generalizations based upon these details the experimenter reserves for a later date. The high regard in which Galileo held experimental facts is reflected in the following from a letter[8] to the Grand Duchess Christina, dated 1615. He says:

> I would entreat these wise and prudent fathers to consider diligently the difference between opinionative and demonstrative doctrines, to the end that they may assure themselves that it is not in the power of professors of demonstrative sciences to change their opinions at pleasure.

Or witness the following paragraph from the "Saggiatore"[9] as illustrating the great weight which Galileo attached to experimental evidence. He says:

> We examine witnesses in things which are doubtful, past, and not permanent, but not in things which are done in our presence.
>
> If discussing a difficult problem were like carrying a weight, then since several horses will carry more sacks of corn than one alone, I would agree that many reasoners avail more than one; but discoursing is like coursing, and not like carrying; and one barb by himself will run faster than a thousand Friesland horses.

In all his thinking nothing is exempt from experiment. Astronomy even, in his hands, ceases to be a purely observational science; for when he wishes to discover whether the bright portions of the moon's surface are rough or smooth, he sets up two surfaces, one rough and one smooth; then illuminates them with Italian sunlight. Desiring to learn at what rate falling bodies gain speed, he devises a time-measuring machine, invents a method of "diluting gravity" and actually measures the rate at which speed is gained. His discussions begin and end with experiment—

[8] "Nat. Ed.," Vol. 5, p. 326. Translated in Fahie's "Galileo," p. 157.

[9] "Nat. Ed.," Vol. 6, p. 340. Translated in Fahie's "Galileo," p. 187.

a method so familiar to us that we forget how recent and powerful it is.

His two great dialogues—one dealing with astronomy, the other with mechanics—abound in experiments—most of them apt and clever. Leonardo da Vinci advocates experiment: Galileo uses experiment.

2. The second great achievement of Galilei was his seizure upon momentum as the fundamental quantity in the science of mechanics, and his demonstration that velocity is a factor in momentum. Galileo was by no means the first to study and discuss kinematical problems.

Benedetti (1530–1590), one of the many distinguished alumni of the University of Padua, had not only expressed dissatisfaction with the artificial distinction between "violent" and "natural" motions, but had gone farther and had paved the way for mechanics and the differential calculus by recognizing the fact of continuous variation in motion: Benedetti[10] had in particular studied oscillatory motion and had shown that such a motion is continuous even when the vibrating particle is at rest at the end of its path. He had, in fact, introduced the modern idea of continuous variation. But none of the predecessors of Galileo had, so far as I have been able to discover, pushed their study of moving bodies beyond the mere consideration of change of position. None of them had recognized the inertia of the moving body as a fundamental—perhaps the fundamental—fact of mechanics. Princes and paupers, for ages, had stumped their toes against bricks and stones: they were doubtless quite as familiar as we with the mere fact of inertia. But to Galileo it was a cardinal fact, because he was the first to see that the future history of a body depends upon its possession of inertia. To him the importance of a motion is, in general, measured by the inertia involved, or, as was then said—the weight involved. Hence he assigned to the product of the weight and velocity of a body the name "momentum," which is merely the Latin word for importance; as a synonym he sometimes uses the word *impetus,* thus emphasizing the impetuosity of motion.

But Galileo never got beyond the point where he measured inertia by weight, as, indeed, engineers still do—all, at least, except electric engineers. The invention of the idea of mass was reserved for Newton. Even Huygens,[11] who first mastered the idea of centrifugal force, never got beyond the point where he measured centrifugal forces in terms of weight, thus avoiding the conception of mass in all his work.

Those who wish to see just how clearly Galileo conceived that the future behavior of a body is connected with its inertia should read those propositions in his "Mechanics"[12] in which he calculates the path of a projectile by assuming that the horizontal speed of a shot, after it has left the muzzle of a gun, continues to be uniform. His repeated use of this principle makes it perfectly clear that he discovered what we now call—and perhaps properly call—Newton's first law of motion. Galileo failed to generalize it by extending it to all bodies, whether subject to the earth's gravitation or not. This Newton did because he had acquired the new concept of mass—that constant property which never deserts a body in any position or condition.

3. The next great step which Galileo

[10] Lasswitz, "Atomistik," Bd. 2, pp. 14–23, gives a good description of Benedetti's work.

[11] Huygens, "Horologium Oscillatorium," Part V., Prop. 13; or Hobart, "School Science and Mathematics," Vol. 11, p. 692 (1911), for translation of Huygens's paper.

[12] Galileo, "Dialogues on Motion," Fourth Day, Problem I. et seq.

made was the discovery of the constant factor in the motion of falling bodies. One of his earliest experiments, performed while still a young man at the University of Pisa, was to allow a bronze ball to roll down a carefully prepared inclined plane, an experiment from which he cleverly inferred that while the position and speed of the ball were changing, the time-rate at which it gained momentum remained constant. It was with reference to these particular experiments that Goethe remarked *"dem Genie, ein Fall für tausend gelte."* The experiment is completed by showing how one can compute the momentum (or speed) of a body after it has been falling for any given time or through any given distance. In all these computations, the unit of momentum employed is that which a body acquires in falling freely through an arbitrarily selected unit of distance.

As illustrating how tenaciously he clings to the idea of momentum, witness the following clear, exact and thoroughly modern definition dating from the year 1604:[13]

> I call a motion uniformly accelerated when starting from rest its momentum, or degree of speed, increases directly as the time, measured from the beginning of the motion.

Observe that we have here, without any mention of the word, precisely the dynamical idea which we to-day use under the name of a *"constant force."* There is, indeed, no necessity for the name; for Galileo attempts nothing more than to discover how the momentum of a body changes, owing to the presence of another body such as the earth in the neighborhood (action at a distance) or owing to contact with an elastic body such as the hot gases of exploding gunpowder in the barrel of a gun (action through a medium). Later generations had not yet beclouded the idea of force with "tendencies to motion"; they had not yet identified it with that vastly more complex "muscular sensation"; they had not yet made it over in the form of a "man"; they had not yet named it an "agent"; they had not yet identified it with a state of stress or strain which one elastic body exhibits when held permanently at rest by another elastic body; still less had there been any attempt to convince people—principally high-school lads and college students—that all these various things are one and the same, since, forsooth, at various times we call them by one name, "force." Some of Galileo's most worthy successors, such as Clifford,[14] Poincaré[15] and Hertz, have pointed out our inconsistent definitions of force, and have advocated in the most outspoken manner, a return to the simple methods of this Italian academician.

The best known of all his experiments is, of course, that in which he proves that the time of fall is independent of weight, an experiment which completes to a first approximation the laws of falling bodies practically as we have them to-day. He accomplishes a second approximation by eliminating the buoyant force of the medium. He is prevented from making a third approximation only because he meets the barrier of viscosity, a barrier which still renders impossible the solution of any but a few simple cases in fluid motion.

The one remaining fundamental phenomenon of falling bodies is that the acceleration of gravity is independent of the substance of which the falling body is composed. This Galileo[16] proved by swinging, side by side, two pendulums, having bobs

[13] "Nat. Ed.," Vol. II., p. 166.

[14] Clifford, *Nature*, Vol. 22, p. 122 (1880).

[15] Poincaré, lecture before the Wissenschaftlich Verein in Berlin, p. 116 (Teubner, 1912).

[16] "Nat. Ed.," Vol. 8, pp. 128–130, First Day, translated into German by von Oettinger, Ostwal's *Wiss. Klassiker*, No. 11, p. 76

of lead and cork, respectively. When the suspension fibers had equal lengths and the pendulums swung through equal amplitudes, they had equal velocities at each point of their path. It is difficult to find, in Newton's hollow pendulum experiment, much more than a second approximation in which he eliminates the air resistance from this experiment of Galileo.

4. The fourth advance which we owe to Galileo is the observation that the momentum communicated to a body in one direction does not alter its momentum in a direction at right angles. This independence of components of momenta, now known as Newton's second law of motion, was in the hands of Galileo no mere philosophical theorem, no vague guess, but a practical rule of action to be employed in mechanical operations. It is by compounding a uniform horizontal velocity with an accelerated vertical velocity that he proves, for the first time, that the path of a projectile is a parabola. It was by means of this principle that he prepared a range-table for gunners. The fact is then that Galileo discovered and employed the first two of Newton's laws essentially as we use them to-day.

It requires more than sheer strength to climb a difficult mountain peak; one must start in on the right trail. More than mere intellectual ability is needed to make an important discovery in physical science; one must start in with the correct viewpoint. This viewpoint is precisely what Aristotle lacked and exactly what Galileo possessed. It is Gomperz,[17] the distinguished historian of Greek thought, who says:

> The physical doctrines of Aristotle are a disappointing chapter in the history of science. They display to us an eminent mind wrestling with problems to which it is in no wise equal.

5. As a minor achievement of Galileo allow me to mention some discoveries to which he blazed a part of the road.

In a letter to a friend he says he had spent more years in the study of philosophy than weeks in mathematics. It is, therefore, extraordinarily surprising to find set forth in his "Dialogues on Motion"[18] all the detailed facts and ideas which are involved in the modern definition of an infinite quantity developed by Boltzano, Cantor, and Dedekind, viz., an assemblage containing a part which may be put into one-to-one correspondence with the whole.

Again he paves the way, in a very distinct manner, for the differential calculus, in pointing out that the definitions[19] of constant velocity and constant acceleration hold only when the times considered are "all whatsoever." If, therefore, one wishes to employ these definitions in the discussion of variable motion he must take his time intervals indefinitely small.

The invention of the well-known thermoscope which Galileo employed in his lectures at Padua also belongs here; for while it is not a true thermometer it doubtless led immediately to those exquisite sealed instruments shortly afterwards constructed by the Accademia del Cimento and still preserved in the Tribuna di Galileo at Florence. The theory of "dimensions," first stated by Fourier, was led up to in the First Day of the Dialogues on Motion.

The principle employed in his measurement of the density of air[20] is one which is not only faultless in principle, but one which makes it plainly evident that Galileo had properly conceived that idea of atmospheric pressure which, in the hands

[17] "Greek Thinkers," Vol. 4, p. 108, Berry's translation.

[18] First Day, "Nat. Ed.," Vol. 8, p. 78.

[19] Third Day, "Nat. Ed.," Vol. 8, p. 191.

[20] "Nat. Ed.," Vol. 8, p. 124, First Day.

of two of his students, led to the invention of the barometer, and, in the hands of von Guericke, to the air pump. Torricelli knew well the Dialogues on Motion.

6. Finally, Galileo was an inspiring teacher and built up at Padua a great school of physics. Many of his students lodged under his own roof; helped him in his own garden; ate at his own table. He had his own workshop and employed his own mechanicians. Generous with his time, his energy and his money, master of a fine literary style, endowed with a keen sense of humor, familiar with the best that had been said and thought in the world, standing in the front rank of investigators, is it any wonder that young men of talent hastened to Padua from all parts of Europe? Could any higher compliment be paid to a teacher than the devotion exhibited by the youthful Viviani, a lad in his teens, for his master already some seventy years old and a "Prisoner in Acetri"? If deferred payments of the kind that teachers mostly depend upon ever get as far as the next world, surely this courageous spirit, harried throughout his long life by poverty, ill-health and the censorship of the church, must have been gratified by the work of the Accademia del Cimento which was, with the exception of a single man, composed entirely of his students. Mechanics was the one subject to which he was devoted consistently and persistently throughout his life; it was the subject of his earliest investigation when a young man at Pisa; the subject upon which he lectured when in his prime at Padua; the subject of his latest and most mature reflection at Arcetri. His most important contribution to dynamics was published in the seventy-third year of his age.

If, in conclusion, I were asked to summarize in a single sentence the principal contributions of Galileo to the science of physics, I should mention the two following facts: (1) That knowledge of physical phenomena which is to receive "impersonal verification" and become useful, must be obtained mainly by experiment adapted to ask of nature some particular question. (2) That momentum considered as a function of time and position is a fundamental dynamical concept; or, in other words, to discover how the change of momentum of any body is connected with the physical circumstances in which the body is placed, is the one great problem of dynamics.

But perhaps, after all, his most important contributions lie outside of physics. Indeed Galileo has not yet shot his last arrow. For his life still teaches us that nothing is so because any man says it is so. His example still shows how experiment can rob a man of all arrogance of opinion, how familiarity with unsolved problems can give a man genuine humility, and how, on the other hand, the possession of clear experimental evidence arms him with sure confidence.

Critics tell us that Florence, during the Renaissance, shone with a borrowed light —a light reflected from Athens. But I venture to think that those who will take the pains to look over the pages of Galileo will find them self-luminous.

Henry Crew

Northwestern University

FACTS AND FICTION ABOUT CROPS

The Association of Official Agricultural Chemists of the United States at the Norfolk meeting, in 1907, unanimously adopted a commiteee report[1] endorsing the following declaration:

> It is as truly the duty of science to protect agriculture from error as it is to afford new truth.

[1] See Circular No. 123 of the University of Illinois Agricultural Experiment Station.

If "the farm is the basis of all industry," as was recently stated by James J. Hill, then science should not fail in this duty; for American agriculture is approaching a crisis, and the use of science must be depended upon to provide adequate support for our rapidly increasing population.

Already the question of food has begun to exert dangerous pressure in the United States, but so much of error and deception has been promulgated that even those who are to occupy the places of highest authority and influence are likely to be led into false positions whose foundations can only crumble beneath their feet.

There is no fiction in the starving poverty of our race in India, nor in the frequent famines of Russia, nor in the history of the dark ages following the ancient civilization of our people in the Mediterranean countries; and neither should the plans for the future prosperity of the Aryan in America be based upon fiction.

EXAGGERATED CROP REPORTS

Careful investigation reveals the fact that the reports from the federal bureau of statistics, as published by the secretary of agriculture, are highly exaggerated and deserving of the strongest condemnation, although all would be glad to give praise if these glowing reports were true; and, if the progeny of ninety-two million people and added millions of immigrants could live upon blind optimism or mere boasting, then duty would not compel this contribution toward the protection of truth and prosperity, by exposing error.

The following quotations are taken from the annual reports of the secretary of agriculture:

From 1905 Report.—Another year of unsurpassed prosperity to the farmers of this country has been added to the most remarkable series of similar years that has come to the farmers of any country in the annals of the world's agriculture. Production has been unequaled; its value has reached the highest figure yet attained.

From 1906 Report.—Economic revolution in the art and science of agriculture, which became noticeable in this country half a dozen years ago, has continued during 1906, with tremendous effect upon the nation's prosperity. Crops so large as to be beyond any rational comprehension have strained the freight-carrying ability of the railroads.

From 1910 Report.—Year after year it has been my privilege to record "another most prosperous year in agriculture." . . . Nothing short of omniscience can grasp the value of the farm products this year. At no time in the world's history has a country produced farm products within one year with a value reaching $8,926,000,000, which is the value of the agricultural products of this country for 1910. This amount is larger than that of 1909 by $305,000,000, an amount of increase over the preceding year which is small for the more recent years.

A notable feature of corn production this year is the growing importance of the south. This has been manifested in a small way in very recent years, but now the increased magnitude of the crop in that section, both absolute and relative to national production, forces itself upon the attention.

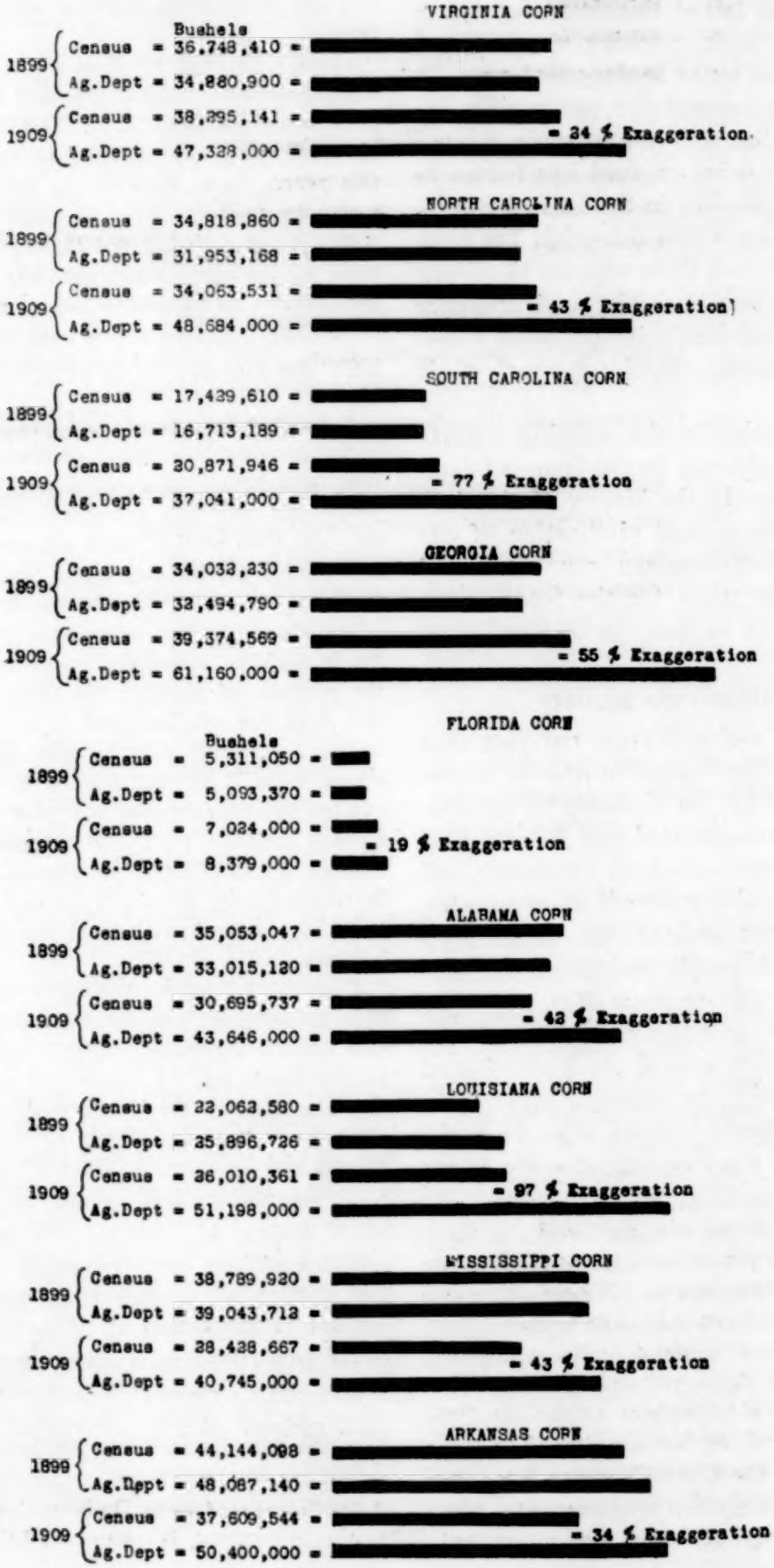
The demonstration work among southern farmers is rapidly increasing. Organized in 1904 for the purpose of fighting the boll-weevil in Texas, this work has now extended to all of the southern states. . . . From 1904 to 1909 there was an increase from 1 to 362 agents in the field. The number has now reached 450, and the demand for more is urgent. . . . In 1909 figures from a large number of demonstrators showed a comparative increase of from 50 to 400 per cent. in the average yield of standard crops, and the figures for 1910 indicate similar results.

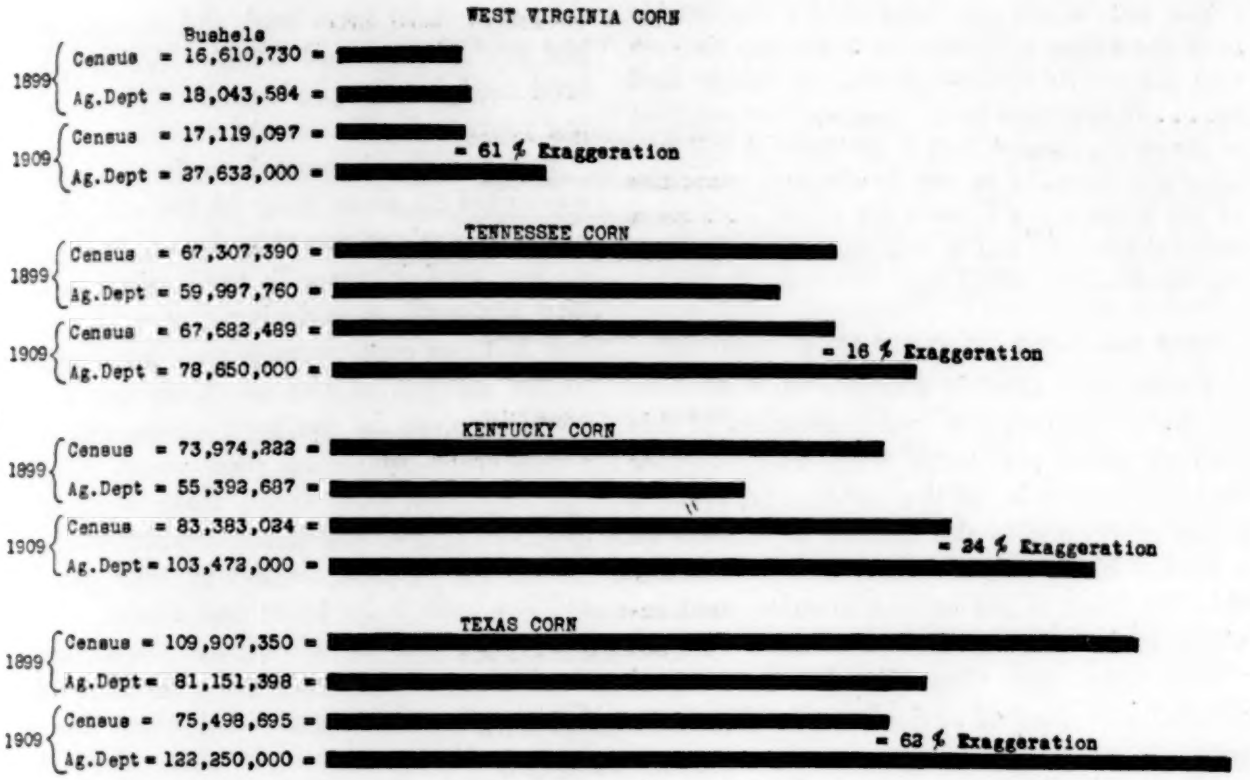
From 1911 Report.—Owing to the prevalence of high prices there has developed a general impression that the agriculture of this country is unequal to the needs of the increasing population. An investigation of the facts with regard to this condition failed to establish any cause for alarm. On the contrary, it is evident that this country has been passing through phases of agriculture in which declines in production per acre are the result of exploiting new land and in which recuperation follows with a greater pace than that of increase of population.

The Department of Agriculture has had success in the south through object lessons in the field, where the best southern farmers in their counties were the instructors. This method should be organized in all the states.

From 1912 Report.—The record of sixteen years

FACTS AND FICTION ABOUT CORN
By U. S. Census and Agricultural Department.





has been written. It begins with a yearly farm production worth $4,000,000,000 and ends with $9,532,000,000. . . . During the past 16 years the farmer has steadily increased his wealth production year by year, with the exception of 1911. . . . Beginnings have been made in a production per acre increasing faster than the natural increase of population.

In the issue of February, 1913, of the *Crop Reporter*, "published by authority of the secretary of agriculture," occurs the following:

Statements have been made recently by some writers and lecturers, to the effect that the yield per acre of crops in the United States is diminishing from year to year. A study of crop yields indicates that there was such a tendency toward lower yields during the seventies and eighties, but during the last 20 years the tendency has been the reverse. . . . In order to show this trend graphically, eight charts are published in this issue of the *Crop Reporter* which show the yearly change and the average change of yield per acre of eight important crops. In these charts the downward tendency until about 1890, and since then the upward trend, is strikingly shown. The recent tendency toward enlarged production per acre is general throughout the United States.

By referring to the *Crop Reporter* for January, 1911, we find a similar statement:

That the final stage of better agriculture and increased production has been reached in many states for a varying number of crops, and that production per acre is not only beginning to exceed the normal increase of population, but really to exceed the actual increase. . . .

The potentiality of agricultural production as a national achievement sufficient for growth of population has been so numerously and so thoroughly demonstrated as to be now beyond intelligent question. The Farmers' Cooperative Demonstration Work, now carried on in 12 cotton states, employs 375 traveling agents and has many thousands of demonstrating farms. It is proving by results on thousands of farms that preparation of the soil so as to make the best seed bed adds 100 per cent. to the average crop on similar lands with an average preparation in the old way; that the planting of the best seed makes a gain of 50 per cent.; and that shallow, frequent cultivation produces an increase of another 50 per cent., making a total gain of 200 per cent., or a crop three times the average crop.

It will be noted that all of this enormous increase is secured with no suggestion of soil enrichment, in strict harmony with the erroneous teachings[2] of the Department's Bureau of Soils:

[2] See Bureau of Soils Bulletin, No. 55, pp. 66, 79, 80; or SCIENCE, November 8, 1912, p. 621.

The soil is the one indestructible, immutable asset the nation possesses. It is the one resource that can not be exhausted; that can not be used up. . . . It is evident that it can not wear out, that so far as the mineral food is concerned it will continue automatically to supply adequate quantities of the mineral plant foods for crops. . . . As a national asset the soil is safe as a means of feeding mankind for untold ages to come.

CROP ESTIMATES MEASURED BY THE CENSUS

Fortunately, there is a trustworthy measure applied to the progress or retrogression of this country every ten years, when every farmer and land owner in all the states must make a sworn statement to the Bureau of Census in regard to his crops and herds; and, fortunately this statement is not subject to subsequent revision or inflation by any "estimates" of the "Crop Reporting Board" with an "optimistic" secretary of agriculture as the chairman.

Thus, while the "crop statistics" of the agricultural department claim an increase of 50 per cent. in the production of corn in the southern states from 1899 to 1909, the data from the U. S. Bureau of Census show an actual decrease of 7 per cent. In other words, the Department of Agriculture reports that the total production of corn for the thirteen states from Texas and Arkansas to the Atlantic, and south of the Ohio and Potomac, was increased by 239 million bushels from 1899 to 1909; while the figures from the Bureau of Census prove that instead of an increase there was a positive decrease of 31 million bushels.

The accompanying statistical data and graphic illustrations reveal the percentage of inflation or boasting by the agricultural department as compared with the census facts relating to corn production in the individual states.

STATISTICAL ILLUSTRATIONS

The census reveals an increase in the population of contiguous continental United States of 21 per cent. during the last decade (from 76 million to 92 million people). The Bureau of Census also found an increase of 4.8 per cent. in farm land, and increase of 15.4 per cent. in *farmed* land, which means the land used for the production of crops, including pasture for live stock.

But has our increased production per acre amounted to more than 21 per cent., as the above quotations would lead us to believe? If so, our total increase in production should be 39.6 per cent., considering that we are farming 15.4 per cent. more acres. But the report of the Bureau of Census shows only 1.7 per cent. increase in the total production of all cereal crops, including corn, wheat, oats, barley, rye, rice, buckwheat, Kafir corn, emmer and spelt, the aggregate production having been 4,439 million bushels in 1899 and 4,513 million bushels in 1909; and a comparison of the crop "statistics" of the Department of Agriculture for these years with the averages for the three-year periods, 1898 to 1900, and 1908 to 1910, respectively, shows that, on the whole, 1909 was a slightly more favorable season than was 1899, for the production of the cereal crops.

An increase of 15.4 per cent. in farmed land with an increase of only 1.7 per cent. in production reveals the truth of reduced yield per acre. And neither official "estimates" nor official boasting can controvert this established American fact.

SHORTAGE OF ANIMAL PRODUCTS

We might expect and hope that a much larger increase would be found in the live stock produced during the decade on the farms of the United States, but instead we find no increase at all. In fact, the number of cattle decreased by six million (from 68 to 62 million head); the swine decreased by five million (from 63 to 58 million head); and the sheep decreased by nine million (from 62 to 53 million head); while horses and mules increased by less than three million (from 22½ to 24 million on farms, and from 25 to 27½ million all told, including those in cities).

(The time of year the counts were taken varied by six weeks, June 1, for 1900, and April 15, for 1910, but even with possible allowances for this variation, the number of

cattle, sheep and swine plainly decreased during the decade.)

THE TRUTH ABOUT COTTON

The cotton crop showed a substantial increase of 11.7 per cent. in total production, and, furthermore, 1909 seems not to have been a favorable season for cotton; but, on the other hand, the acreage in cotton increased by 32 per cent. from 1899 to 1909; and the combined reports of the Department of Agriculture (on acreage) and of the Bureau of Census (on production) reveal the fact that the yield per acre of cotton was not only less in 1909 than in 1899, but the average yield per acre for the four years 1907, 1908, 1910 and 1911, was also less than the average for the four years 1897, 1898, 1900 and 1901. This notwithstanding the boasted influence of the hundreds of "best southern farmers in their counties," who accepted appointments on the Department's pay roll as "field agents"; and it is a question of exceeding importance whether the "farm demonstrators" of either the south or the north should be appointed by the secretary of agriculture. Should they not rather be appointed by the agricultural colleges of the respective states, in order that they may be selected because of their thorough training in the scientific principles which must constitute the foundation of truly permanent systems of agriculture, as well as for their knowledge and experience in the science and practise of agriculture in their own state, and be held directly responsible to their home people? There is the gravest danger that a federal appointee in every county will often exert more influence politically than agriculturally.

POTATOES INCREASE

The reports of the Bureau of Census show that the only important increase in crops of large significance for food is in potatoes, a crop that is grown to a considerable extent on the market gardens enriched by heavy applications of animal fertilizers from the city, produced, of course, at the expense of the farms which supply the cities with hay and grain.

DECREASE IN EXPORTATIONS

When we consider the facts revealed by the Bureau of Census, it is not strange that, in order to feed our increasing population, we were compelled to decrease our exportation of wheat for making bread, and of corn for making meat. As an average of the first four years of Secretary Wilson's administration (1897 to 1900), compared with the average for 1907 to 1910, our annual exportations decreased from 210 million to 108 million bushels of wheat, and from 196 million to only 49 million bushels of corn. (These are not estimates, but facts.) In percentage of total "estimated" production, the corn exports decreased from 10 per cent. to 2 per cent., and wheat exports decreased from 37 per cent. of our production for 1897 to 1900, to only 16 per cent. of the production for 1907 to 1910.

THE GREATEST DECEPTION

And yet, if we ignore the census facts, and accept only the "estimates" of the Department of Agriculture, a comparison of averages of the "statistics" for these two four-year periods would show that, after deducting the actual exportations, our average annual supply for domestic consumption increased during the decade from 359 million to 575 million bushels of wheat, and from 1,806 million to 2,741 million bushels of corn; or, in other figures, these four-year averages would show that our supply of wheat for bread increased during the decade by 60 per cent., and that our domestic supply of corn for the production of meat, etc., increased by 52 per cent.; whereas, our population increased by only 21 per cent. during the same decade.

Thus the only real basis for the common complaint of the people regarding the food supply is that they can not live on "statistical" fiction.

In his annual report for 1912, Secretary Wilson makes the following generous statement:

> The great and growing movement carried on by the department for agricultural betterment has not been sustained solely by one man.

It must also be recognized that the faults

of the department, including the condemnable inflation of crop "statistics," and the wide promulgation of erroneous theories, such as have emanated from the Bureau of Soils, advocating doctrines which can lead only to land ruin, are not all to be set down as the sins of one man. There have been in the service of the United States Department of Agriculture, some of the most eminent scientists the world affords, and other conscientious public servants, including, unquestionably, many of the field agents; and so have there been others whose public "service" is far worse than worthless.

Cyril G. Hopkins
University of Illinois

THE AMERICAN PHILOSOPHICAL SOCIETY AND PRESIDENT WILSON

On Wednesday of last week a committee of the American Philosophical Society consisting of President W. W. Keen, Hon. Charlemagne Tower, Hon. Elihu Root, Secretary Charles D. Walcott, of the Smithsonian Institution, President Robert S. Woodward, of the Carnegie Institution, and Director Otto H. Littmann, of the U. S. Coast and Geodetic Survey, were received by President Wilson, by special appointment in the east room of the White House, and presented to him, on behalf of the society, the following congratulatory address on his accession to the presidency.

To His Excellency Woodrow Wilson, President of the United States:

Sir: The American Philosophical Society extends its cordial congratulations to you, as one of its fellow-members, upon your accession to the presidency of the United States. You carry into public life the ideals of the scholar; and you will show in the New World, as has been proved so often in the Old, that philosophical training, in the best and broadest sense of the term, is a help to the practical statesman. Your studies in history and in political science will illuminate your task of giving to the nation a wise and strong government.

It was Montesquieu, the good genius of the makers of our national constitution, who said that for a safe voyage for the ship of state the spirit of the laws should serve as compass and history should be the chart. This society confidently believes that you have at your command this compass and this chart; that with your firm hand at the helm the ship of state will safely ride the seas; and that you, like those of your distinguished predecessors in the presidency who were its members, will help to make the future history of the nation worthy of its past.

Seven times since the founding of the Republic the American Philosophical Society has had cause for congratulation in the selection of one of its members as President of the United States. Washington, Adams, Jefferson, Madison, the second Adams, Buchanan and Grant were honored names upon its roll before the popular vote inscribed them in the list of American Presidents. To you, the eighth in turn of its members to enter upon this high office, this Society extends its warmest greeting.

Given under the seal and in the name of The American Philosophical Society held at Philadelphia for Promoting Useful Knowledge this seventh day of March, 1913.

W. W. Keen,
President

I. Minis Hays,
Arthur W. Goodspeed,
Amos P. Brown,
Harry F. Keller,
Secretaries

The president thanked the committee for the presentation of the address and later he made a more formal acknowledgment as follows:

The White House, Washington,
March 19, 1913.

My Dear Dr. Keen: May I not express to you, and through you to the members of the American Philosophical Society, my deep and sincere appreciation of the cordial message brought me from the society by you and your associates this afternoon?

Nothing has gratified me more. I do not know of any association whose confidence I would rather enjoy. It has been a matter of peculiar pride to me to be associated with the American Philosophical Society, and that that distinguished body should feel honored by my elevation to the Presidency is a source of genuine satisfaction to me. I can only say in reply to their gracious address that I shall hope and strive at all times to deserve their respect and confidence.

Cordially and sincerely yours,
Woodrow Wilson.

Dr. William Keen,
Philadelphia, Pa.

SCIENTIFIC NOTES AND NEWS

IT is announced that Dr. H. B. Fine, professor of mathematics in Princeton University, has been offered by President Wilson the ambassadorship to Germany.

DR. DAVID F. HOUSTON, secretary of agriculture, will retain the chancellorship of Washington University on leave of absence. Professor F. A. Hall, dean of the college, has been appointed acting chancellor.

PROFESSOR WILLIS LUTHER MOORE, who has been chief of the United States Weather Bureau since 1895, will retire from this office on July 31.

DR. ELIE METCHNIKOFF, assistant director of the Institute Pasteur, Paris, has declined the directorship of the Institute of Experimental Medicine at St. Petersburg, vacant by the death of Dr. B. Podvyssotzky.

THE ministry of public instruction of the French government has selected Dr. Maxime Bôcher, professor of mathematics in Harvard University, as exchange professor for 1913–14. His term of service will fall in the winter semester and will be spent at the University of Paris.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has leave of absence to go to Europe in the interest of the peace movement.

PROFESSOR ARTHUR SCHUSTER, F.R.S., has been elected president of the Physical Society, London.

PROFESSOR W. M. DAVIS, of Harvard University, has been elected honorary member of the Hungarian Geographical Society at Buda-Pest, and foreign member of the Swedish Anthropological and Geographical Society at Stockholm.

ON March 1 there was given in New York City, at Delmonico's, a dinner to Professor Russell H. Chittenden, director of the Sheffield Scientific School of Yale University, by his former pupils and a few other friends. Nearly one hundred were present, there being representatives of almost every Yale class from 1874 to 1908. Dr. Frank S. Meara, '90, acted as toastmaster and addresses were given by Dr. John A. Hartwell, '89 S., chairman of the committee having the dinner in charge; Professor Graham Lusk, '96 Hon.; Professor Henry H. Donaldson, '79; Professor W. T. Sedgwick, '77 S.; Professor Harvey Cushing, '91; Dr. Elliott P. Joslin, '90 and '91 S.; Dr. P. A. Levene, and Professor Chittenden. At the close of the speaking, Dr. Meara announced that the National Institute of Social Sciences had voted a medal to Professor Chittenden in recognition of the distinction he has attained in original investigation in the field of physiological chemistry. Dr. H. Hollbrook Curtis, '77 S., secretary of the institute, made the presentation. Professor Mendel then presented to Professor Chittenden a set of engrossed resolutions which had been adopted by his fellow members of the board of trustees of the Sheffield Scientific School. It was announced by the committee, through its chairman, that Professor Chittenden's pupils were desirous of expressing their appreciation of his work in some such way that it might have a permanent value, and that to this end there was being raised the Russell H. Chittenden Fund, the income from which should be expended for the benefit of the department of physiological chemistry in the Sheffield Scientific School.

ON March 25, 1914, Geh. Ober-Regierungsrat Professor Dr. A. Engler, professor of botany in the University of Berlin, director of the Royal Botanic Garden and Museum at Berlin-Dahlem, member of the Academy of Science of Berlin, will celebrate his seventieth birthday. In order to commemorate this occasion, his friends in Germany and throughout the world have issued a circular letter requesting that subscriptions toward a marble bust be sent to Professor Dr. Wittmack, Berlin, N. W. 40, Platz von dem neuen Tor 1. The bust will be made by Herrn Bildhauer Manthe, of Schmargendorf.

PROFESSOR RALPH HOAGLAND, head of the division of chemistry of the College of Agriculture, University of Minnesota, has resigned and gone to Washington, D. C., where he will enter on his work in the Bureau of Animal Husbandry.

H. B. Humphrey, formerly head of the department of botany in the State College of Washington, has been appointed to fill the position of pathologist in charge of cereal disease investigations in the Bureau of Plant Industry of the Department of Agriculture.

Professor E. O. Jordan, of the department of pathology and bacteriology in the University of Chicago, has accepted an invitation to become a member of the national commission for the determination of a standard of purity for drinking water. This commission has been formed in connection with the enforcement of regulations relative to pure drinking water, and its object is to establish a federal standard which shall be generally applicable.

Professor George D. Strayer, of Columbia University, has been appointed chairman of a committee of fifteen of the National Council of Education to report on standards and tests of educational efficiency.

Donald F. MacDonald, geologist of the Isthmian Canal Commission, left Panama on March 11 for a month or more of geological exploration in the interior of Panama. The work will be carried on under the auspices of the Smithsonian Institution.

Mr. Vilhjalmur Stefansson lectured before the members of the Royal Geographical Society on March 10 on "The Arctic Islands and their Eskimo Inhabitants." Mr. Stefansson, as has been announced, is at the head of a scientific expedition which will start from Victoria, British Columbia, in June, to explore the Arctic shores of Canada and to make further studies of the Eskimos of Victoria Island on behalf of the Canadian government.

Professor Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, who has been the Barrows lecturer for six months in the chief cities of India, China and Japan, will resume his regular work at the university near the opening of the spring quarter. The Barrows lectureship, which was established by Mrs. Caroline E. Haskell, provides for a series of lectures in the orient every three years on the general subject of the relations of Christianity to other religions.

On March 8 Professor S. F. Acree, of Johns Hopkins University, lectured before the chemistry department of Princeton University on "The Reactions of Both the Ions and the Non-ionized Forms of Electrolytes."

On March 12 Professor Hugo Münsterberg delivered a lecture at Johns Hopkins University on "Psychology of Labor."

Mr. Frank P. Stockbridge, editor of *Popular Mechanics,* will give a series of weekly lectures on journalism to the students of the course in journalism at the University of Wisconsin this spring.

A course of four public lectures on the theory of the solid state, has been delivered at University College, London, by Professor W. Nernst, director of the Institute of Physical Chemistry in the University of Berlin.

A number of friends, colleagues and pupils of the late Paul Segond have planned a memorial fund in honor of the memory of the surgeon. The income will be used to help internes approved by the council of the Faculté de médecine at Paris to pursue research work and to prepare for their examinations.

It has been decided to perpetuate the memory of the late Alderman C. G. Beale, vice-chancellor of Birmingham University, by (1) the endowment or partial endowment of a chair in the university to be selected hereafter by the university council, and to be called the Beale chair; and (2) a collection of British birds and their nests, mounted in their natural surroundings, to be placed in cases in the first room of the future Birmingham Natural History Museum. Sir Charles Holcroft has promised a donation of £5,000, to be devoted to the endowment of the university chair and there are other gifts amounting to £4,000.

In November last a meeting of old students and friends of the late Professor Tait was held in the physical laboratory of the University of Edinburgh, Principal Sir William Turner presiding, when a committee was appointed to establish a memorial. The com-

mittee has now decided to recommend the raising of a fund of from £20,000 to £25,000, for the purpose of endowing a second professorship of natural philosophy in the university. The proposed chair would be connected with the department of Professor Tait's work in which he achieved especially conspicuous success, namely, the application of mathematics to the solution of physical problems, including those which bear upon engineering and other departments of applied science; and the committee feel sure such a chair would not only form an appropriate and worthy memorial, but would also be in itself of the highest utility. The committee are making every effort to bring the project to the attention of all old students, both at home and abroad, and they are confident of getting into communication with over 6,000 of them. They feel justified, however, in appealing not to old students merely, but also to men who were associated with the professor in any department of his work; to natural philosophers, mathematicians and scientific men generally, who through their study of his publications have become indebted to him as a teacher; to those who are interested in the progress of the Scottish universities, and recognize the great value of his services to education; and to such of his fellow citizens as take pride in his scientific eminence and recall with interest his picturesque personality. The hon. secretary, Professor J. G. MacGregor, the University, Edinburgh, will be glad to furnish any information that may be desired, either by letter or, in cases in which it may be possible, by personal interview. Subscriptions should be sent to the honorary treasurer, Sir George M. Paul, 16 St. Andrew Square, Edinburgh.

A MEMORIAL to the late Sir J. D. Hooker, which has been placed in the parish church at Kew, near the similar memorial to his father, Sir W. J. Hooker, was unveiled by Lady Hooker on February 22. It consists of a mural tablet of colored marble bearing an inscription, below which is a Wedgwood medallion portrait of Sir Joseph, flanked and supported by five panels containing Wedgwood figures of plants with which there had grown up some especial association.

THE death is announced, at the age of ninety-one, of Major-General Henry Clerk, who was elected a fellow of the Royal Society so long ago as 1848. He was the author of papers on the strength of timber, and the flow of liquids through small orifices and other subjects.

DR. RUDOLPH FRANK, professor of surgery at Vienna, has died at the age of fifty years.

IT is stated in *Nature* that Mr. R. J. Balston, of Maidstone, has presented to the British Museum (Natural History) his well-known collection of humming-birds. The birds are mounted and arranged in forty-nine cases, each of which contains a group of two or more species. The total number of specimens in the collection is stated in Mr. Balston's manuscript to be 3,315, representing 162 genera and 480 species. Of these, 2,674 are skins, and 199 nests, some of the latter containing eggs. As soon as arrangements are made for its reception the series will be placed on exhibition in one of the corridors on the first floor of the zoological department. This collection and the Gould collection will render the exhibited series of humming-birds one of the finest, if not actually the finest, in the world.

THE Peabody Museum of American Archeology and Ethnology of Harvard University, has recently received two important acquisitions. The first is a valuable collection of prehistoric pottery from the mounds of the Red River region, Arkansas. This pottery, which is the gift of Mr. Clarence B. Moore, '73, of Philadelphia, Pa., came to the museum in several hundred fragments. They have now been cemented together and added to the regular exhibit. The other acquisition is a large collection of stone implements from the Island of Grenado, W. I., the gift of Dr. Thomas Barbour, '06.

A WEEKLY journal entitled *Die Geisteswissenschaften* has been established under the editorship of Dr. Otto Buek, of Berlin, and of Professor Paul Herre, of Leipzig, published at Leipzig by Veit and Co. The scope of the journal includes philosophy, psychology, mathematics, religion, history, philology, art,

law, sociology and education. The announcement states that the journal undertakes "für das Gebiet der Geisteswissenschaften ein ähnliches Programm verwirklichen, wie ihm für die Naturwissenschaften in England die 'Nature,' in Amerika die 'Science,' in Deutschland 'Die Naturwissenschaften' nachstreben."

We learn from *Nature* that the will of the late Mr. Rowland Ward, the taxidermist, directs that the trustees with respect to his charitable bequests shall expend 500*l.* per annum out of the income of his residuary estate, after the legacies and annuities specified have been paid, for a period of ten years in the purchase of specimens to be presented to the Natural History Museum, South Kensington. The residue of his estate is left in equal shares to such eight of fourteen selected charitable and other institutions as his widow shall choose. In default of his widow's selection within twelve months of the testator's decease, the whole of the fourteen institutions —which include the Natural History Museum —are to share equally.

The only public standardizing and testing laboratory for public utilities and industries generally, outside of the one maintained by the Bureau of Standards at Washington, has just been established by the regents of the University of Wisconsin, in cooperation with the Wisconsin Railroad Rate Commission. The purpose of the university's new laboratory is to render more direct service to public utilities and to industries of the state by supplying them at a reasonable cost with the opportunity to have meters and similar instruments scientifically tested. Hitherto the smaller public utilities and industries that could not afford to maintain testing laboratories of their own have been compelled to have their testing done as favors by a few large companies that could maintain testing laboratories.

The following lectures are being given at the University of Minnesota:

January 17—"Eugenics and Race Betterment," Dr. Victor C. Vaughan, dean of the department of medicine and surgery, University of Michigan.

January 28—"Cancer and its Prevention," Dr. L. B. Wilson, of the Mayo Hospitals, Rochester, Minnesota.

February 11—"Heredity and Environment," Dr. E. L. Tuohy of Duluth.

February 25—"The Nature of Disease," Dr. W. T. Councilman, professor of pathologic anatomy, Harvard Medical School.

March 11—"Public Health a Public Duty," Dr. Mazyck P. Ravenel, professor of bacteriology, University of Wisconsin, and director of the Wisconsin State Hygienic Laboratory.

April 1—"The People's Responsibility in Dealing with Public Health Problems," Dr. H. M. Bracken, executive officer, Minnesota State Board of Health.

April 15—"The Need for an Efficient National Health Service in the United States from an Economic Standpoint," Dr. John B. Murphy, professor of surgery, Northwestern University Medical School.

April 29—"The Profession of Medicine; an Agency in Social Service," Dr. Richard Olding Beard, professor of physiology, University of Minnesota.

May 6—"The Growth of Hygienic Ideals," Dr. Henry B. Favill, professor of medicine, Rush Medical College.

The United States Bureau of Education has just published a *Bibliography of the Teaching of Mathematics,* covering the period from 1900 to 1912, by David Eugene Smith and Charles Goldziher. This bulletin gives 1,849 titles of books and articles on the teaching of mathematics that have appeared since 1900. The bulletin will be sent free upon application to the United States Commissioner of Education, Washington, D. C.

We learn from the London *Times* that an arrangement has been made for cooperation between the British board of trade and the principal Atlantic steamship lines in carrying out during the present year the recommendations of the merchant shipping advisory committee in their report on life saving at sea with respect to stationing a vessel for ice observation to the north of the steamship routes across the North Atlantic. In accordance with the advice of a special conference summoned by the board of trade to consider the best means of giving effect to this recom-

mendation, it is proposed that a vessel should be stationed off the east coast of North America to the north of the steamship routes during the coming spring to watch the break-up of the ice and to report its movement on the way to the routes. The *Scotia*, a whaler, formerly employed in the Scottish Antarctic Expedition, has been chartered to carry out this work, and it is anticipated that she will be ready to leave Dundee, where she is at present lying, about the end of this month. The vessel is being fitted with a Marconi wireless installation having a long range, so that she will be able to keep in touch with the wireless stations in Newfoundland and Labrador. The cost of the expedition will be shared between his majesty's government and the principal Atlantic steamship lines. In order to make the necessary observations in connection with the movement of the ice, there will be three scientific observers in the *Scotia*. As the vessel will from time to time be stationary, it is expected that these observers will be able to make oceanographical and meteorological observations as to currents, etc., which will be of general scientific interest, as well as of direct value to the work in hand. The *Scotia* is a wooden barque of 357 tons, built at Drammen in 1872, and is fitted with an auxiliary steam engine.

EIGHT trains sent out to all parts of Wisconsin by the College of Agriculture of the University of Wisconsin to demonstrate better farming methods reached 32,275 people, according to the report of the men in charge of the trains. These trains traveled about the state for thirteen weeks stopping every little way to give farmers an opportunity to visit them, and learn how their crops and livestock could be improved. Men from the agricultural college accompanied each train and lectured wherever stops were made. The trains were of three kinds. One kind was devoted to livestock, another to grains, and the third to potatoes. In the livestock trains prize animals were shown together with exhibits illustrating the care and feed of them. Lectures and informal talks on the value of using pure-bred animals and kindred subjects, supplemented the various exhibits. Exhibits illustrating the good results attending the use of high-grade seed grains, how to improve the quality and yield of potatoes, etc., were shown in the grain and potato demonstration trains.

WITH Admirals Bradford and Chester in attendance, Captain J. L. Jayne, superintendent of the U. S. Naval Observatory, inaugurated Monday afternoon, February 10, a system of fortnightly meetings of the scientific staff for the discussion of topics relating to the work of the observatory. Professors Skinner and Frisby, now retired, but formerly for many years actively engaged in the work of the observatory, also took part in the proceedings. The paper of the afternoon, by Dr. W. D. Horigan, librarian, on "The Founding of the Observatory," detailed the meager progress of astronomy in this country during the eighteenth and the early part of the nineteenth centuries, and traced the efforts of various learned men and statesmen to establish a national astronomical observatory, up to the crowning of their efforts in the founding of the U. S. Naval Observatory in 1842. For the bringing about of this event the scientific world is directly indebted to Lieutenant J. M. Gilliss, U. S. Navy. In the discussion following the paper, Admiral Chester, formerly head of the observatory, stated that the paper should be printed in order that astronomers the country over should benefit by the thorough researches of the author.

ACCORDING to the *Journal* of the American Medical Association the American Telephone and Telegraph Company, the Western Union Telegraph Company and the Western Electric Company have made public a comprehensive plan for the payment of sick benefits and life insurance for their 175,000 employees. It is said that $10,000,000 is available for this purpose. In connection with this pension plan there is to be gradually established a system of medical supervision and preventive sanitation designed to preserve the health of employees. The preventive measures will not only include early detection of disease among

employees, but also a supervision of sanitary conditions in offices and workshops and the instruction of employees in hygiene. The plan does not necessarily propose to furnish medical attendance to employees, but it will aid them in securing prompt and efficient treatment. Arrangements will be made with hospitals throughout the country for the prompt reception of those who seek this kind of treatment. It is believed by the companies that this plan will be an economical advantage to both parties. Dr. Alvah H. Doty, formerly health officer of the port of New York, has been appointed director of this department.

With a view of elucidating the history of native cotton, Mr. Frederick L. Lewton, of the U. S. National Museum, has written a pamphlet entitled "The Cotton of the Hopi Indians: A New Species of *Gossypium*," forming publication No. 2,146 of the Smithsonian Miscellaneous Collections. The fact that cotton was used and of necessity cultivated by the Indians, is recorded by several early Spanish explorers, as it has been more recently by many ethnologists. In the villages of the cliff-dwellers of Mesa Verde National Park numerous fragments of cotton cloth have been unearthed, and, in Utah, the seeds of the plant itself have been found. To-day, among the Hopi Indians of Arizona, the cotton plant is highly esteemed, and its fiber enters into many of their ceremonies, as well as into many practical household activities. It is considered essential by them that all strings employed in religious services be of native cotton. These strings of cotton are used to bind together prayer sticks and offerings of all kinds, and are placed in the trails entering the pueblos where ceremonial services are in progress; the badges of the chiefs are all wrapped with native rough-spun cotton strings; and cotton is also used to weave ceremonial kilts, belts and wedding blankets. Unfortunately the native Hopis, once deft in the art of weaving blankets, mantles, rugs and other articles from cotton, now find it far easier to purchase either the yarn already spun, the cloth already woven, or the complete garment, and thus the art is gradually being lost. Cotton is still cultivated by them, however, to a small extent, in a village in the western Navajo Reservation and in another of the Moqui. The Department of Agriculture has carried on experiments with Hopi cotton for the past seven years. This particular species of cotton is remarkable in the rapidity with which it grows and the early date at which it blooms, it being the earliest to blossom of several hundred species put to test. Plants of this species have borne ripened bolls in eighty-four days from the sowing of the seed. Following a pertinent discussion as to the history and development of this particular sort of cotton, Mr. Lewton describes botanically the distinguishing features of a new species which he calls *Gossypium hopi*, and which is illustrated by five plates showing the growing plants, the flowers and the maturing and ripe bolls.

How the county "poor" farms of Wisconsin are being utilized to convince farmers of the advantages of up-to-date methods of agriculture, is explained by F. B. Morrison, assistant to Dean H. L. Russell, of the University of Wisconsin College of Agriculture, in the current number of the university's alumni magazine. In 1909 the college of agriculture instituted field demonstrations on several "poor" farms. The most approved methods of agriculture are put into practise on these fields so that the farmers of the surrounding country can see for themselves the results of simple improvements over their own methods. Each county farm is also made the center for distribution of pure-bred seed grain, bred scientifically at the college of agriculture. The demonstration fields are located on main traveled roads so that farmers passing by may see the results during the entire growing season. Farmers are always welcome at the demonstration fields and are encouraged to ask as many questions as possible. When the demonstration crops are at their best an annual demonstration picnic is held to which all the surrounding farmers and their families are invited. Sometime during the day of the

picnic all the participants are taken out to the demonstration fields and there the methods used to secure high yields are explained by professors from the agricultural college. How popular these meetings are is shown by their growth in attendance. In 1909 the average number present at a meeting was 80; this year it was 450. A notable result of these demonstration fields and demonstration picnics is the great improvement in agricultural methods in the sections where they are in force.

UNIVERSITY AND EDUCATIONAL NEWS

THE London correspondent of the *Journal* of the American Medical Association writes that the British government has made arrangements for taking part in the tropical diseases exhibition to be held at Ghent this year. The London School of Tropical Medicine, the Liverpool School of Tropical Medicine, the Cairo and Khartum schools, the navy and the army will be represented. Each of these organization has been given certain diseases to illustrate in a popular manner, so that people may realize what is being done to make the tropics habitable to mankind. The cases will contain specimens of the insect pests which are the cause of the spread of disease in the tropics, with examples of the culture of bacteria taken from their blood, and numerous microscopic and photographic views of the development of the different stages. In all, thirteen diseases will be illustrated. The London School of Tropical Medicine will make a complete display of the work in progress in connection with cholera, beriberi and elephantiasis, including any fresh information available consequent on the outbreak of cholera among the Balkan troops. The Liverpool school will set out the work that is being carried on against yellow fever and sleeping sickness, diseases in which the school has specialized for a long time. The admiralty will exhibit what has been done by the fleet surgeons in the matter of undulant fever, more commonly known as Malta fever, and due to the goats of the island. The war office will take up that scourge of all armies, typhoid fever, and will depict the results of the study in the prevention and cure of the disease. Plague comes under the direction of the India office, and Dr. Andrew Balfour, of the Egyptian service, will make a special exhibit dealing with leprosy and other eastern diseases. Most, if not all, of the exhibits will make an important feature of the part played by flies, mosquitoes, fleas and rats in the distribution of disease. Part of the display is intended to inform the public how best to guard against these insect pests. Mosquito-proof houses, mosquito-proof clothing, and even mosquito-proof books are to be on view. A rat-proof house will be included in the departmental exhibits. There will be several examples of foods which have been deprived of their nutritive qualities, such as polished rice, which causes beriberi. The Liverpool school, which deals with this subject, will exhibit tinned foods from which the nutritive properties have been withdrawn in the process of preserving.

THE Arkansas general assembly has appropriated $36,000 for the medical department of the University of Arkansas for the biennial period ending March 31, 1915.

LAKE ERIE COLLEGE has obtainel the sum of $200,000 for general endowment.

THE Tucker fund committee at Dartmouth College has established a fellowship of the value of $1,200 which may be renewed for a period of three years; the holder of the fellowship may study at an American or foreign university and at its expiration must be prepared to accept an instructorship at Dartmouth College.

DR. CHARLES F. MYERS, of New York City, has bequeathed $25,000 to Acadia University, Nova Scotia, to establish a professorship of biology.

MR. AUGUSTUS NASH has bequeathed the residue of his estate in trust to pay a near relative the income during life, and afterwards to pay the capital sum to Bristol University in the hope that it may be used to ad-

vance natural sciences, particularly chemistry. The sum will be about £18,000.

The four largest courses in Harvard College last year were government 1 with 479 undergraduates, economics 1 with 438, philosophy E (elementary psychology) with 373, and chemistry 1 with 333. The other two courses which had over 200 undergraduates were philosophy A, Professor Palmer's course on the Greek philosophy, with 272, and history 1 with 250.

The vice-chancellor of the University of Cambridge has appointed April 19 for the election to the Plumian professorship of astronomy and experimental philosophy, vacant by the death of Sir George Darwin. Candidates are requested to send their names to the vice-chancellor on or before April 11.

Professor Henkel, of Königsberg, has been appointed director of the institute of pathology at Breslau, as successor to Professor Ponfick.

Professor Hoffman, of Prague, has been appointed to succeed Professor L. Hermann as director of the institute of physiology at Königsberg.

DISCUSSION AND CORRESPONDENCE

A SIMPLE FORMULA FOR COMPUTING GYROSCOPIC FORCES IN AN AEROPLANE

The recent letter of Mr. James Means, in Science for December 13, 1912, has called renewed attention to the problem of the gyroscopic action of a revolving motor as affecting the safety of an aeroplane. The following simple formula for computing the magnitude of this gyroscopic action is offered as a contribution toward the symposium suggested by Mr. Means.

We shall regard the rotating motor as consisting essentially of a single wheel or disc, whose axle is supported by two bearings at known distances from the center of the wheel.

If the aeroplane is compelled by the rudder, or by a sudden gust of wind, to change its direction of flight, this compulsion may be thought of as due to the pressure of a flat board against the side of the axle, at a point, say, in front of the wheel. As is well known, the axle will resist this pressure on account of the gyroscopic action of the rotating wheel, and will *strive to move off at right angles to the impressed force,* and in so doing, will *strive to carry the whole aeroplane with it.* If the wing surface of the aeroplane is large, this motion will be practically entirely prevented by the resistance of the air, and the result of the gyroscopic action will be the setting up of *internal stresses* in the framework of the machine.

The object of the following formula is to provide a simple means of computing the maximum value of these internal stresses in any given case.

Let a = the distance between the bearings, measured along the axle, in *feet,* and let P = the pressure, due to gyroscopic action, on each bearing, in *pounds.* Then P is given by the following formula:

$$Pa = (0.00034\ldots)Wr^2Nn,$$

where

W = weight of the rotating wheel, in *pounds,*

N = angular velocity of the rotating motor, in *revolutions per minute,*

n = the angular velocity with which the aeroplane is turning out of its path, measured in *revolutions per minute,* and

r = the radius of gyration of the wheel about its axle, in *feet.*

Note 1.—A fair estimate of the radius of gyration can be obtained by a mere inspection of the linear dimensions of the wheel. For example, if the wheel were a homogeneous disc of radius R, then $r = (0.7)R$, approximately; while if all the material were concentrated in the rim, then $r = R$; intermediate cases can be judged by the eye.

Note 2.—The coefficient 0.00034 ⋯ represents the value of $\pi^2/900g$, where $g = 32$ ft. per sec. per sec. If the lengths r and a are measured in *centimeters* instead of in feet, this coefficient must be replaced by 0.0000112⋯. If r and a are measured in *inches,* the coefficient is 0.000029 ⋯.

As an illustrative numerical case, suppose $W = 167$ lbs. (which is the actual weight of a fifty-horse power Gnome motor), $N = 1{,}200$

revolutions per minute, $n = 5$ revolutions per minute (estimated), and $r = 2/3$ ft. (estimated). Then if $a = 1$ foot, we shall have $P =$ about 150 lbs.; or, if $a = 2$ ft., $P = 75$ lbs., etc.

It thus appears that under ordinary conditions of flight, the effect of these gyroscopic forces could hardly be serious.

In conclusion, we note the following simple rule for determining the *direction* in which the force P will be exerted. (This rule was first published by the writer in the *Engineering News* for June 21, 1910. See also *The Scientific American* for November 23, 1912.)

Imagine the deflecting force (that is, the force which compels the aeroplane to change its direction of flight) to be due to the pressure of a flat board against the spinning axle (say in front of the motor), and *note the direction in which the axle, if rough, would tend to roll along the board;* this will give the direction in which the (forward) end of the axle will tend to move as the result of gyroscopic action—that is, the direction in which the force P will act against the (forward) bearing.

For example, suppose the axle is spinning in the clockwise direction, as seen by an observer looking forward, and let the aeroplane make a sharp turn to the *left;* then the forward end of the axle will strive to *rise.* Similarly, if the aeroplane makes a sharp dive *downward,* the forward end of the axle will strive to turn to the *left.*

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FUR-BEARING MAMMALS: AN UNAPPRECIATED NATURAL RESOURCE

The manor of living nature is so ample, that all may be allowed to sport on it freely; the most jealous proprietor can not entertain any apprehension that the game will be exhausted, or even perceptibly thinned.

In such wise did Dr. Richard Harlam, writing in 1825, comment on the inexhaustibility of our natural game resources. As late as 1857 the following in substance appears in the report of an Ohio state senate committee:

The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the north as its breeding grounds, traveling hundreds of miles in search of food, it is here to-day and elsewhere to-morrow, and no ordinary destruction can lessen its numbers, nor can those killed be missed from the myriads that are yearly produced!

The tragic story of the passenger pigeon is familiar to every one. Not so familiar, perhaps, are similar stories which may be told of other species. Fortunately, there is a growing realization that our national resources in wild life are rapidly dwindling, and attention is being directed toward checking the extermination.

This consideration comes not a moment too soon. Unless protective laws are enacted before a species is nearly extinct they can not ordinarily avail much. Nevertheless, vigorous efforts should be made continually not only to conserve species which are still plentiful, but to preserve species which, through our lack of foresight, are on the verge of extinction.

There is, however, one department of our fauna which, in the opinion of the writer, has hardly received its deserved quota of attention. I refer to the several species of fur-bearing mammals whose pelts have a commercial value. The species concerned include the bear, raccoon, skunk, badger, otter, sea otter, mink, marten, fisher, red fox and wolverine.

It is estimated on fair authority that there are within California alone trappers in the proportion of ten to the county, each of whom makes a possible average of five hundred dollars from his annual catch. There are fifty-seven counties, so that five hundred and seventy persons with a total income for the fur season of $285,000 a year would on this estimate be resident in the state. Two hundred and eighty-five thousand dollars is the interest at four per cent. on $7,125,000. This, or even a quarter of it, would seem to be enough of a commercial asset to be worth at least some legislative consideration.

On the basis of figures quoted by Ernest Thompson Seton[1] it appears that an extremely

[1] "Life Histories of Northern Animals," 1909.

conservative estimate would place the revenue to North America as a whole for the last seventy-five years from the furs of the raccoon, badger, wolverine, fisher, marten, mink, otter, red fox and large striped skunk at $222,735,000, and to the United States at $113,950,000. This is an average value per year of a little less than $3,000,000 to North America as a whole, and $1,500,000 to the United States. Three million dollars is the interest at four per cent, on $75,000,000 and $1,500,000 is the interest at four per cent. on $37,500,000.

Thus a conservative estimate shows that $37,500,000 is the "capital invested" by the United States in the fur-bearing mammals listed. These figures, while not especially large, do indicate that the fur value of these species has been appreciable! It should be remembered, too, that the furs of such damage-doing species as bear, coyote, wolf, mountain lion, lynx and wild cat are not listed in this estimate. That the fur trade total would be considerably swelled by the inclusion of the last-named mammals is indicated by the fact that Brass[3] has shown that the *annual* value of all North American furs during the years 1907–09 averaged one hundred million marks, or about $25,000,000. My estimates given above are probably below the actual figures even for the species included. Twenty-five million dollars is the interest at four per cent. on $625,000,000, which represents the approximate money-value of all North American fur-bearing mammals.

It is clearly apparent that there are good economic reasons for the protection of some of our mammals at least. The need of conservation is beginning to be keenly felt in California, where trappers in the Sacramento Valley recently testified to the writer that practically all fur-bearing species are rapidly decreasing. There is much wanton destruction of these animals during the summer season when their fur is worthless. The grizzly bear, the noblest member of our California fauna, is now practically extinct. The sea-otter, possessing the highest fur value of all our mammals, formerly existed in great numbers off the coast of western America, and is also a vanishing species. The dismal story of dwindling numbers and final extinction seems about to be repeated in the cases of certain animals with which we are now dealing as though the "manor of living nature" was inexhaustible.

We are confronted with two facts: first, America's crop of fur is economically profitable, and second, the mammals on which this harvest depends are in most cases decreasing in numbers. We may dispose of these mammals in one of two ways: (*a*) They may be appropriated to man's use as rapidly as possible, with no thought of future supply. Their money-value thus becomes a perfectly definite sum, which can not be added to when the species become extinct. (*b*) They may be wisely conserved, heed being paid to the future. Their economic value under this method would either remain at about the figure at which it now stands, or would increase, and the fur-bearing mammals would be of permanent instead of transitory worth in dollars and cents. For instance, in California we could count on a quarter of a millon dollars coming into the state annually which would not otherwise find its way here.

Upon proposing legislation it becomes immediately apparent that there are difficulties. Several of the animals mentioned are charged with various offences against the farmer. Others are to some extent predatory on game fishes and game birds. There is strong suspicion in the minds of some that their depredations are in many cases not so serious as certain of the indictments against them would indicate. But the lack of information does pointedly emphasize the need for more data as to their numbers and habits.

Nature-history museums may be relied upon for some of these desiderata, but at best there is no doubt that our knowledge is yet fragmentary and inconclusive. A state trapper's license, be it ever so small, would give data as to numbers of trappers and amount of trapping done which would be invaluable to legislators desiring to adopt a wise conservation policy. Perhaps more important

[3] "Aus dem Reiche der Pelze," 1911, p. 356.

even than this would be a thorough investigation by the various state and provincial game or conservation commissions of the habits of the species concerned, with special reference to food preferences and commercial values.

Protection of those species whose numbers are not yet reduced below a critical point would doubtless be possible and adequate. Conservation of beavers has been successful in such cases. Nature distinctly favors some of the species through their practically inaccessible habitats, or their self-protective instincts. It is evident that protective legislation would consequently vary with the species and with the conditions of its existence in particular localities. Where one mammal may require a five-year closed season, another may need protection during the breeding season only, and for still another, protection may be altogether unnecessary at present.

There is further reason for paying heed to these elements of our fauna. The fact that man is the dominant species does not justify his wanton extermination of any members of the living world around him. It has taken nature geologic ages to evolve these animals, and it is our duty to be considerate in our dealings with subordinate forms of life.

There is no resurrection or recovery of an extinct species, and it is not merely that here and there one species out of many is threatened, but that whole genera, families and orders are in danger.

Dr. Mitchell in a recent number of SCIENCE[5] has forcibly called attention to a number of facts, full of sinister warning to those who dislike to stand by and see the careless destruction of our native fauna. Allow me to quote again for the sake of emphasis:

Each generation is the guardian of the existing resources of the world; it has come into a great inheritance, but only as a trustee.

In the opinion of the writer the intrinsic interest and the humanitarian arguments, as well as the economic one, emphasize strongly the desirability for wise attention to this lesser problem of the fur-bearing mammals, none the less than to the careful conservation of all the rest of the wild life yet remaining at our disposal.

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[5] 1912, p. 353 and following.

THE WRITINGS OF WILLIAM G. SUMNER

TO THE EDITOR OF SCIENCE: A little over a year ago the Yale University Press published a collection of essays by the late Professor William Graham Sumner. It is now proposed to publish another volume to be called "Earth Hunger and Other Essays," during the fall of 1913 or a little later. In connection with this enterprise, I wish, as editor, to bespeak your assistance.

It is desired, in this proposed volume, to collect (aside from more extended matter) all of Professor Sumner's shorter publications. Many of his best and most characteristic utterances were brief articles, struck off on occasion, and widely scattered in newspapers and magazines. We have little trouble in finding his longer articles, but it is difficult to locate many a short and vivid fragment. Since the other volume was issued, not a few suggestions have come to our ears to the effect that another time we should not overlook this or that pregnant utterance—some striking thing which has riveted the attention of our courteous censor, and which he would like to have at hand. Sometimes such a constructive critic can not remember just where or when he has seen such an article, and suggests vaguely that it was "in the papers," or "in one of the weeklies."

Now we want all these scattered materials, and it has occurred to me that suggestions might be forthcoming as to their whereabouts, if our present effort to make a final and exhaustive collection of Sumneriana were announced to your readers. We should be glad to examine any materials that might come within the scope of the proposed volume, and to receive any suggestions, however vague, as to utterances, brief or extended, from the pen of Professor Sumner. Materials sent me in care of the Yale University Press will be acknowledged and promptly returned after examination.

As this volume will, in all probability, close the collection of Sumner's printed works in the line of essays and short pieces, those who can assist us in securing available materials will confer a substantial favor.

Albert G. Keller

LEST WE FORGET

To the Editor of Science: The new administration, with democratic majorities in both house and senate, was entrusted with power in the belief that it will be responsive to the needs and demands of the people. But in the various programs suggested for the amelioration of present-day abuses nowhere has any mention been made of the early adoption of the metric system as an obligatory system in this country, accompanied by the destruction of the old systems. The writer has reached that second childhood when, at the request of his children for aid in doing their "sums," he must again wade through the chapters in the arithmetic devoted to the various tables of hodge-podge units, and he realizes, as never before, the truth of the statement that the whole thing is "a wickedly brain-destroying piece of bondage under which we suffer."

To see young minds eager for the study of live subjects forced to work hundreds of useless problems in this treadmill of heterogeneous dead and dying units is enough to rouse the ire of any one against those selfish interests which are blocking the way of reform.

When we consider the situation candidly we must acknowledge that the matter is one of extreme importance. A great part of the under-weight and false-measure frauds are directly due to our confused system of units, and on the adoption of the metric system under such protective regulations as are in force in Germany, for example, a tremendous saving would be effected in the cost of living to wage earners especially. Can not all scientists, who understand so well the merits of the metric system, rouse themselves and make a strong effort to have the bill passed which has been before congress for many years, backed by the various government bureaus and reform leagues? It took thirty years to obtain the parcel post; must we wait that long? Or can we not make a long pull, a strong pull, and a pull all together, and get it through next winter?

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TO WHOM IS THE ACADEMIC COSTUME WORTH WHILE?

To the Editor of Science: Even if we disagree on the use of medieval costume in modern institutions as a matter of academic good taste, may we not set our faces against any participation in the decision by a commercial propaganda aiming to extract large profits from members of an underpaid profession?

T.

SCIENTIFIC BOOKS

Cambrian Brachiopoda. By Charles D. Walcott. Monograph U. S. Geological Survey, Vol. 51. Part I., Text. Part II., Plates. 1912. Pp. 872, 76 text figures, 104 plates.

The dominating impression which this extraordinary work leaves upon one who runs a hasty eye over its pages and luxurious plates, is that of the marvelous industry and enthusiasm of its author. If the paleontological genius who controlled these facts here assembled had nothing else to do, the wonder might be less. But amid the responsibilities of a great office and affairs of widest scientific concern, the writer of this book seems to let no minutes go to waste which can be made to forward his expositions of that field in paleontology of which he has long been the most effective illuminator.

Here are two quarto volumes devoted, by title at least, exclusively to the Brachiopods of the Cambrian fauna. Nearly twenty years ago students of this multitudinous, variant group of animals believed the sum of knowledge concerning them enough to justify a treatise on the broad lines of their generic characters, so Professor James Hall and his assistant published two big quartos on this subject, therein searching out every nook and cranny that might afford traits of generic sig-

nificance in all known or available forms of these creatures. Even to such a study the Cambrian brachiopods cut a very modest figure in paleontology. Specimens were few, their structures were obscure, and hence their relations were difficult to interpret; most of the available material was poorly preserved and, as a whole, they played a dubious rôle in the generic history of the entire class as well as in the total of the Cambrian fauna.

In this new book the student may scan 104 crowded plates of the Cambrian Brachiopods, bearing from 3,000 to 4,000 figures, and after the first bewilderment has passed, he comes to the realization that at last a definite progress has been made in the census, the analysis and estimate of the morphology and biologic worth of these early and hence most significant organisms.

The columns of SCIENCE are hardly the place for a critical study of Dr. Walcott's results or a measurement of their advance over previous knowledge. The author's publications on various aspects of the Cambrian fauna have been as startling as rifle shots and as effective in opening our eyes to the unexpected development of life within this field. With this book before us, inherited and acquired notions of the paucity of life in this "primordial" age of the earth are forever swept aside. The present panorama of the Cambrian Brachiopod fauna is simple in aspect but numerically comparable to the brachiopod element in any later geological age. At any rate here are listed about six hundred species and only the census taker for the class would dare say how far any single subsequent period has overpassed that number. As against their successors in the later rocks they lack in diversity of expression, for these are simple, sturdy, coherent types, largely devoid of the sudden and fugitive variations which accompany the tachygenic, arrested and declining stages in succeeding faunas. The author had the courage, years ago, to break the restraints of geography and politics and to content himself with nothing less than the earth for his field. Above a thousand localities are cited in his lists here and it is the Cambrian terrane of the world which the author has been enabled to reach through many direct and indirect avenues; yet the substantial basis of the work is his own discoveries in regions of his own exploiting.

It is probably not the proper business of a notice of this work to analyze the part it has played in the ecology of the author, but the author is, for the moment, impersonal as is any author who may have achieved so tremendous an addition to the details of scientific fact. These kernels of knowledge are not easy to assimilate, they seem to go hard with even the spiritually minded seeker after all truth, and one may be disposed to wonder if the joy of discovery, the sense of contribution, the rebound of satisfaction which comes with each new determination of fact, is not the great reward in such achievement. But here let us go slowly. If the whole truth were to be known and the real underlying genius of life could be indisputably portrayed, I presume the difference between *Lingulella cuneola* and *Lingulella desiderata* might prove to be as vital in the Grand Plan and to the Sum of Happiness, as the winning or losing of a congressional appropriation for a museum of industry. Nevertheless, no man can be so deeply conscious of the worth of such a work as the man who did it; no one can appreciate so well the broader bearings of such a monumental increase of human knowledge. Fortunately it is not of the sort that has to be applied to meet human expediencies. Hence its glorious justification.

The greater volume of the text of this work is given over to the descriptions of the species, but there are preliminary chapters of broader scope, among them none more suggestive than the analysis of differential shell structures. Following Beecher's broader classification of the brachiopods, based on the characters of the pedicle passage, *Atremata, Neotremata* and *Protremata* (the first and second corresponding to Huxley's *Inarticulata,* and the third to the *Articulata*) the majority of species and genera are *Atremata,* and they, with the *Neotremata,* are as much in excess of the rest here as they are over-

passed by the higher *Protremata* in the later faunas. This is as it should be, for they are diverse expressions of the simplest brachiopod structure. Broadly speaking, regardless of their multitude, the species of the major divisions are all oboloid or linguloid in outline. The disk of the oboloids has been oft repeated in the geological history of the brachiopods, though it has served to mask widely distinct genera; but as for the sharpened *Lingula*-form—it would seem there was a divinity that shaped its end, for it has come down to this day without much change, just enough in fact to let us say that no true *Lingula* existed in Paleozoic time, hard as it might be to prove it. One can not restrain surprise at the beauty of retention of much of this material, the perfection of shell structure, of pallial venation, ovarian and muscular impressions, set forth on the plates by extremely effective mechanical processes of illustration. The quality of this illustration is most admirable, and it would seem that the personal error of portraiture has been here reduced to its lowest terms.

Should one, on cursory examination of this host of newcomers in paleontology, wondering over their relationships, their phylogeny and precedence, venture to whisper to himself of *Orusia eurekensis* or *Otusia utahensis*—who was its father? who was its mother? had it a sister? had it a brother?—these wisely suppressed inquiries are answered on page 317, which graphically sets forth the presumed derivative relations of the genera discussed. This page is exceedingly instructive. Beecher found the brachiopod radicle best expressed in the Cambrian genus *Paterina,* and his proposition still holds pretty well under these later studies. Walcott's radicle is hypothetic and Precambrian, and its most direct expression and outcome is his genus *Rustella* which, leaving no successors (in this table), stands out in independence as the fortified protegulum adult. Nearest to this in close collateral development stands *Paterina,* a durable genus reaching nearly through all Cambrian beds. From a distinct collateral descend the oboloids and in a near-by line, but distinct as far as it has been tracked, the linguloids. These three lines constitute the main stocks of the *Atremata.*

The *Neotremata* with definite cardinal surfaces (such genera as *Acrotreta, Acrothele, Trematobolus*) indicate no marked convergence toward the *Atremata.* Mr. Walcott unites them close to the Precambrian radicle. This also he does with the *Protremata* (*Billingsella, Syntrophia,* etc.). Indeed, one of the striking features of this table is its palpable absence of evidence of Cambrian convergence in the three great subclasses.

In 1892–94, when Hall and Clarke's "Introduction to the Study of the Genera of Paleozoic Brachiopoda" and "Introduction to the Study of the Brachiopoda" appeared, there were 28 recognized Cambrian genera. Dr. Walcott presents a total of 49 genera and subgenera of *Atremata* and *Neotremata* from the Cambrian. But it is to be noted that, notwithstanding its title, the work is not exclusively given over to the Cambrian faunas. The author has included a number of related genera and species, of all three subclasses, from the Ordovician, which help to make clearer the relations and range of these primitive expressions.

The scientific public knows that even with this vast contribution to our knowledge of the Cambrian fauna, Dr. Walcott's work is very far from complete. We have been let far enough into his accumulated Cambrian treasures to realize that his brachiopod book is but a foretaste, an intimation of the whole fauna under his eye. We can not restrain amazement at the tremendous expansion of ideas regarding the profusion and diversity of the Cambrian fauna which has followed the work of his hands. It is his own fault if we are led daily to expect the unexpected from this rich depository of life. In beauty and excellence of preservation the Cambrian beds of the Canadian Rockies, which he has especially upturned, surpass nearly all deposits of a later date, and with the light that they have cast upon familiar organisms long known to us from later beds, we have now to rehabilitate many familiar conceptions. In ultimate

significance the bearing of these investigations on the life conditions which preceded the Cambrian, is far-reaching, and must pave the way to a repair of our conceptions of it and gives us, too, a certain hope that unremitted diligence may bring to our distinguished protagonist of Precambrian life a sure and firm reward.

JOHN M. CLARKE

Nutritional Physiology. By PERCY G. STILES, Assistant Professor of Physiology in Simmons College; Instructor in Physiology and Personal Hygiene in the Massachusetts Institute of Technology, Boston. 12mo of 271 pages, illustrated. Philadelphia and London, W. B. Saunders Company. 1912. Cloth. $1.25 net.

This little volume is a most welcome addition to the literature of nutrition. It is seldom that as much information of a reliable and useful kind is condensed in a publication of this size. The author well states that "the making of the book has been a study in elimination." He also states that it is intended to be used with other books and suggests the desirability of supplementary reading upon general biology, human anatomy, food chemistry and dietetics. We are informed that the keyword of the discussion is energy. The author has given us a careful and discriminating study of the best existing scientific evidence related to the physiological phases of human nutrition and he has treated his subject in language that is notably clear. His discussion is well organized and he has exercised a reasonable caution in his affirmations. Chemical formulæ and minute details have been excluded from the text and "used but sparingly in the notes," for "a certain preliminary knowledge of elementary science is assumed." The volume deals with processes rather than with chemical or physiological details. For instance, in discussing the unlikeness of the individual proteins on the basis of the "building stones" into which they may be separated, no detailed list is given of the protein cleavage products, but at the same time the general bearing of the knowledge we now have in regard to protein cleavage and the nutritive relation of single food proteins upon the development of body proteins is clearly and fully presented. The origin of urea is discussed, but it is assumed that the student is familiar with the chemical reactions involved. In fact, we have presented to us the philosophy of nutrition minus minute chemical and physiological details. The evident intention is to give to the student a point of view and this purpose is accomplished with eminent success.

One of the characteristic features of this book is the type of illustrations used in order to make clear certain metabolic processes and nutritive relations. For instance, in dealing with the difference in the constructive value of the individual proteins, comparison is made to a house that is pulled down in order that another may be erected from its timbers. "If the second house is of an architecture entirely unlike that of the first, there will be many unavailable pieces to discard and the new building will be smaller than the old. It is not at all unlikely that the misfit fragments of building material will go into the cellar of the new house, later to be used as fuel. This is just what the body does." The structure of a molecule of food protein is also compared to type set up in a printed page. If this type is allowed to fall apart, it is a symbol of digestion and unless this is used to set up again exactly the same matter, there will be unused letters, just as in the human body protein building stones will be used for fuel purposes and not for construction unless the food proteins and the body proteins are alike in constitution. Familiar illustrations of this apt character are frequently used throughout the volume.

If any one portion of this volume is to be commended above another, it is the chapter upon the hygiene of nutrition. Though covering but twenty-three pages, this chapter has more value in its relation to practical dietetics than some whole volumes written by a less scholarly and discriminating author. In discussing nervous conditions as relating to digestion, some space is given to the treatment

of children as affecting the digestion of their food. It would be well if all parents could be made to heed the author's suggestions in regard to thoughtlessness in rebuking children at the table and the almost cruel practise of forcing them to eat what they dislike. The statements that "there is an element of hypocrisy in the attitude of parents who are selecting precisely what they please to eat while compelling little children to swallow food which repels" and "to oblige a child to finish a plateful of food against its inclination may be crass brutality" are forceful and should be heeded by those who have the care of the physical development of children.

The reader can but wish that the author had been more free in the use of cuts, for those which are given are very helpful.

W. H. Jordan

New York Agricultural Experiment Station

Studies in Radioactivity. By W. H. Bragg, M.A., F.R.S. Macmillan. 1912. Pp. x + 196. $1.60.

Physics owes to Professor Bragg two of the most important of its recent advances. He first conceived and successfully carried out experiments on the "range" of corpuscular radiations and on the "stopping power" of different substances for these radiations. These experiments, with those on scattering, which inevitably followed, have been chiefly responsible for such additions as have recently been made to our knowledge of the internal structure of the atom. The first 10 chapters—104 pages—of the book in hand are taken up with a presentation in clear, non-mathematical language, of the present status of our knowledge of "range," "stopping power," "scattering" and "ionization" as these terms apply to the α and β particles. This material, culminating in C. T. R. Wilson's beautiful photographs of the tracks of α and β particles, probably marks the end of the conception of the positive charge of the atom as a uniform sphere of positive electrification. It seems to demand instead some sort of a Saturnian atom.

Bragg's second important contribution has consisted in the amassing of evidence for the inter-convertibility of β rays and X rays, or β rays and γ rays. This evidence is presented in the second half (pp. 104–196) of his book, which deals wholly with studies on the nature of X and γ rays. That this evidence is exceedingly convincing admits of no dispute, but that it can be successfully interpreted in terms of a neutral pair theory is more than doubtful. Indeed so rapid have been the strides made during the past year in establishing the essential identity of X rays and light that I fancy that Professor Bragg himself would today interpret all his results in terms of an ether pulse theory instead of a neutral doublet theory, but it would have to be an ether pulse theory of the J. J. Thomson sort, in which the energy remains localized in space instead of being distributed uniformly over the wave front. For a clear statement of the apparent necessity for some sort of a localization of radiant energy in the wave front the second half of Professor Bragg's book could scarcely be excelled. One might wish that the author had brought out more emphatically the parallelism between the behavior of X rays and ultraviolet light, for it is in this parallelism that the chief argument against the neutral doublet theory is found.

The book is invaluable to every student of the absorbing problem of the nature of radiant electromagnetic energy.

R. A. Millikan

University of Chicago

BOTANICAL NOTES

POLYSTICTUS VERSICOLOR AS A FOOD PLANT

In the course of some investigations made by Professor M. R. Gilmore in August, 1912, on the knowledge and use of the indigenous plants by the Dakota nation of Indians, the economic botany of the Dakotas, he learned of the use of *Polystictus versicolor* as a human food. The Dakota name is *Cha*^{n} *na*^{n} *pa*,[1]

[1] The raised n signifies a vanishing sound something like the French n.

which literally means "wood-ears" or "tree ears," the name, no doubt, being suggested by the shape of the fungus. It is used when young and tender and is prepared by boiling. Mr. Gilmore's informant was a man probably more than sixty years of age, speaking only the Dakota language, a man of more than average intelligence, a judge in the Indian court of the Wakpamni district of Pine Ridge Indian Reservation. He is of the Ogallala tribe of the Teton Dakotas.

AN EVERYDAY BOTANICAL MANUAL

THERE is evidently no good reason in these days for ignorance concerning the names and general classification of at least the higher plants, if we may judge from the attempts that are made by writers and publishers to supply popular manuals and handbooks. Some of those published in the past have not had much more to commend them than the wish on the part of the writer to help people who were more ignorant than he concerning the plants of some more or less vaguely defined area of North America. And yet the poorest of these had some value, and no doubt helped many people who could not have been induced to buy a better book. No doubt botanists have sometimes been unduly impatient with books of this description, while the non-botanical public has managed to get some of the information about plants which it craved, and which it could not find in the more accurate scientific publications.

But these merely tolerant words need not be used in regard to Dr. C. A. Darling's "Handbook of the Wild and Cultivated Flowering Plants," which made its appearance the latter part of 1912. The preface states that the object of the book is "to furnish a convenient and easy means of determining the wild and cultivated flowering plants found in the East." In carrying out this plan the author has used dichotomous keys of a kind so easily followed that with proper care one need not "run off the track" before finding the name of his plant, in its proper place in its family, order, subclass and class. A hint is given as to the proper pronunciation of the scientific name when found, and an English name is provided for every species. A good glossary and (single) index closes this handy little book of 264 small octavo pages.

If this little book can find its way into the hands of the persons for whom it has been prepared it will serve a most useful purpose, and this part of the public may well feel indebted to the author who in addition to his duties as an instructor in botany in Columbia University has taken upon himself the very considerable labor of writing and publishing this little book.

THE EVOLUTION OF PLANTS

ONE of the most helpful books for the beginner in philosophical science is Professor D. H. Campbell's "Plant Life and Evolution," in Holt's American Nature Series, which appeared some months ago. It will be remembered that a dozen or so years ago the same author brought out a book entitled "Lectures on the Evolution of Plants," in which he emphasized the structural side of his topic. The book now under consideration, while considerably less technical, is really a supplement to the earlier work. That book arranged plant structures in evolutionary sequence; this one accounts for the structures, and their changes by a discussion of the factors concerned. The earlier book was structural, this one is philosophical. The first one appealed primarily to the botanist, while this one will appeal to a much wider circle of readers, in proof of which we may cite some of the chapter headings: *e. g.*, factors in evolution; the origin of land plants; environment and adaptation; the problem of plant distribution; the human factor in plant evolution; the origin of species, etc.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

SUPPLEMENTARY NOTE ON THE SIGNIFICANCE OF VARIETY TESTS

SINCE the appearance in SCIENCE[1] of a note "On the Significance of Variety Tests," Dur-

[1] N. S., 36: 318–320, 1912.

ham[2] has arranged the data of the trials of peas made at Wisley in 1911[3] in a convenient form for statistical analysis.

Comparison with the wheat data already discussed is interesting. In wheat, selection has been *primarily* in the same direction—largeness of yield in bushels per acre—for all varieties. In peas, it has been in diverse directions. For the character here dealt with—time required for development—the tendency has been, consciously or unconsciously, to differentiate widely the varieties. Hence in the pea data, it is idle to lump all the materials together, for any constant thus obtained would be largely spurious and insignificant.[4] In practical tests one must decide between a series of closely similar strains—not between those which are widely and obviously differentiated; hence, we split the material up into the four classes recognized by Durham, that is, into 81–90, 91–100, 101–110, 111–120 day peas and calculate the inter-period correlation[5] for each class separately for the only economically important character[6] for which data are available—total days required for the formation of usable pods. Hence, designating by the subscripts 1, 2, 3, the three successive cultures of 1909[7] we have the following relationships:

For 91–100 day peas, $n = 30$,
$r_{12} = .16 \pm .12$, $r_{13} = .19 \pm .12$, $r_{23} = .12 \pm .12$
For 101–110 day peas, $n = 40$,
$r_{12} = .43 \pm .09$, $r_{13} = .37 \pm .09$, $r_{23} = .78 \pm .04$
For 111–120 day peas, $n = 18$,
$r_{12} = .27 \pm .15$, $r_{13} = .50 \pm .12$, $r_{23} = .45 \pm .13$

All the values are positive. Their wide fluctuation and the magnitude of the probable errors is probably largely attributable to the necessary smallness of the number of varieties in each class.

It is clear that a single test when carried out in the manner of those of the Royal Horticultural Society has little decisive value concerning the merit of a variety. This is not intended as a criticism of these tests, for they are in comparison with many others apparently of a very high order of merit. But certainly they lend their emphasis to the point[8] made in the preceding paper.

Is it not time for a concerted and systematic effort on the part of those interested in agricultural science to put this important problem on a sound basis, biologically and statistically?

J. Arthur Harris

Cold Spring Harbor, N. Y.,
December 21, 1912

On the Metamorphosis of an Amœba, Vahlkampfia sp., into Flagellates and Vice Versa[1]

An amœba of the limax group isolated, in 1909, from tap-water in Oakland, California,

[2] Durham, F. R., "An Analysis of the Pea Trials at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 38: 67–72, 1912.

[3] "Pea Trial at Wisley, 1911," *Journ. Roy. Hort. Soc.*, 37: 403–424, 1911. The two original papers must be consulted for the details that are here excluded for lack of space.

[4] As a matter of fact these constants have been calculated for another purpose, but they need not be published here.

[5] To be of value in determining the relative merit of varieties the performances of a given strain in a test should be a good basis for prediction as to the results of a subsequent experiment. To what extent this is true may be determined for any two or more series of trials of a number of varieties by determining the coefficient of correlation between their performances, correction being made when symmetrical tables are involved—*i. e.*, when any determination is used both as a first and as a second member of a pair—for environmental heterogeneity from experiment to experiment. This does not apply to the pea data.

[6] The data for the individual growth periods give, on the basis of the total data, such irregular correlations that it is not worth while to consider them for the subclasses.

[7] Had the cultures been made at the same season in three succeeding years, the test would have furnished data of more value to the practical grower. Data for such tests are, as far as I am aware, not available.

[8] This has already been emphasized on general grounds by various students of agronomy. See especially C. V. Piper and W. H. Stevenson, "Standardization of Field Experimental Methods in Agronomy," *Proc. Amer. Soc. Agron.*, 2: 70–76, 1910.

[1] Presented to the Cincinnati Research Society, January 9, 1913.

was studied during the past year under varying conditions of environment. The culture contained the descendants of a single amœba grown in symbiosis with a single species of bacillus.

My work was started with the idea of investigating the physical and chemical conditions necessary for the growth of this particular amœba. When, in the course of the work, it was discovered that the trophozoits had the ability to turn, apparently at will, into actively motile flagellated forms, my efforts were directed mainly towards investigating, first, the effects of varying environment upon the morphology and development of the amœba and, second, the conditions which led to the production of flagellated forms.

The trophozoits usually possess a single nucleus with the large karyosome and thick nuclear membrane characteristic of members of the limax group.

The flagellated forms vary in shape, but are most often egg-shaped or pyriform, with the nucleus situated at the pole, from which two long, delicate flagella arise.

These flagellates disappear instantly if a thin cover-glass is placed on a preparation, but may be watched for varying lengths of time in a hanging drop. The metamorphosis of one may be described briefly as follows: For a while it maintained the elongated form; then became pyriform, and whirled round and round, and in a minute or so, during its gyrations, it projected numerous waves of blunt pseudopodia; shortly it became elongated again. It progressed in this form until twenty minutes after the observation commenced, when it suddenly became motionless and spherical. In a few moments it projected a clear blunt pseudopod into which the endoplasm flowed and then it wandered off as a typical trophozoit of the limax type.

Throughout a long series of cultural experiments it was found that this metamorphosis occurred very inconstantly. Traces of various monovalent and bivalent salts seemed to exert no beneficial effect. Daily observations on one subculture were made during more than two months without revealing any flagellated forms. However, it was finally discovered that if the trophozoits were first grown in hen's ovomucoid containing a trace of the egg yolk, the development of the flagellated forms was favored. Furthermore, that they could be constantly obtained if the cultivations were carried out in hanging drops placed in contact with an abundant supply of free oxygen.

The technique is as follows: a loopful from the surface of a yolk-ovomucoid culture containing the trophozoits is mixed with two or three loopfuls of distilled water on a coverglass and placed on a Barber moist chamber at 22°–25° C. No flagellates may be seen in an hour or so, but hundreds may be seen after three or four hours.

Two "pure lines"—each originating from a single flagellate—were obtained for me by Dr. G. L. Kite, by means of the Barber isolation pipette. Both of these showed a much greater tendency to flagellate than the original stock.

Since the ability to turn over into a flagellated stage has been established as a generic character, a technique which will enable one to determine this power is evidently of importance.

In 1912 Chatton and Lalung-Bonnaire established the new genus *Vahlkampfia* (in honor of E. Vahlkampf, who was the first to make known the characteristic mitosis of these amœbæ) to include those members of the limax group which had the ability to flagellate. These amœbæ are said to be always uninucleated. Nuclear division is by promitosis. They multiply after nuclear division by simple fission. Their cysts are always uninucleate.

My findings show that these generic characters must be greatly extended. For example, under certain cultural conditions the trophozoits form endogenous buds; under other conditions, characterized by a reduced oxygen tension, the nucleus apparently divides repeatedly by amitosis, without division of

the cytoplasm, thus giving rise to large multinucleated forms containing as many as thirty or forty nuclei. When these multinucleated forms are placed in contact with an abundant supply of free oxygen the cytoplasm immediately begins to divide. Furthermore, the free oxygen supply starts off many of the multinucleated forms and their nuclei divide simultaneously.

These findings have raised the question, in my mind, as to the validity of the multinucleated genus *Pelomyxa* and the binucleated genus *Sappina*.

It may be of interest to describe here a reaction which I believe indicates the presence of peroxides in the living cell. When these amœbæ are grown in ovomucoid containing a trace of sodium carbonate and then mounted in an aqueous solution of Grübler's methyl green, the granules within their cytoplasm exhibit a purple color in a few minutes. The nucleus does not give this reaction. Now methyl green is split by peroxides into a purple compound and this reaction occurs in the test tube only, in my experience, in the presence of traces of sodium carbonate.

If this reaction really indicates the presence of peroxides, it shows that the so-called "nutritional granules," or "plastids" in reality perform an important part in the oxidations of the cell, and would seem to add significance to the observation of Kite and Chambers, who found that the nucleus of the spermatogonia of the squash bug was composed of powerful reducing substances.

The complete details of this work will be sent to the *Archives für Protistenkunde*.

Wm. B. Wherry

Cincinnati, Ohio

THE ILLINOIS STATE ACADEMY OF SCIENCE

The fifth annual meeting of the Illinois State Academy of Science was held at Bradley Polytechnic Institute, Peoria, Illinois, on February 21 and 22, 1913, under the presidency of Professor Henry Crew, of Northwestern University. After the opening business was transacted, the president's address was given by Professor Crew upon the title, "An Italian Academician." This address presented Galileo as an experimenter of the highest type—one who used the method of science in discovering some of the truths of nature at a time when the common practise was to deal with assertions about nature, or if the apparent facts of nature seemed to controvert assertions "to stare nature out of countenance." It is hoped that this excellent address will receive wide publication, for Professor Crew's special studies of the work of Galileo have resulted in the presentation of Galileo as a man of very much more far-reaching significance to modern science than most scientists have thought. Another special feature of the program was a symposium upon the "Science of Sanitation." The topics and speakers in this symposium were: "The Influence of Shallow Wells on Health," by Edward Bartow, director of the Illinois Water Survey, University of Illinois; "The Control of Stream Pollution," by Paul Hansen, Illinois Water Survey, University of Illinois; "Sanitary Aspect of Milk Supply," by P. G. Heinemann, department of bacteriology, University of Chicago; "Housing in Relation to Health," by Marion Talbot, department of household administration, University of Chicago; "Birth and Death Registration," by Frederick R. Green, American Medical Association, Chicago. This symposium proved unusually interesting to all the members who were present, and it is hoped by means of the annual volume of the academy's *Transactions* to give the symposium papers wide distribution throughout the state.

After an informal reception for members and friends of the academy, an excellent dinner was served by the department of domestic science of Bradley Polytechnic Institute; and in a period when efficiency in education is being demanded everywhere, it is a pleasure for the members of the academy to attest the efficiency of the service given by Bradley's domestic science department. The dinner and the service was entirely by students in the department, and no better dinner has been served to the academy. The after-dinner program consisted of a series of short addresses outlining the nature and significance of the past year's discoveries in each of several branches of science. This apparently impossible task was performed in such a way as to give the members a good perspective regarding the chief occurrences and the dominant points of view prevailing at present. The speakers were John M. Coulter, Henry B. Ward, Stephen A. Forbes, William S.

Bayley and E. W. Washburn. One of the purposes of the academy is to make science the property of the people, and no part of the program better met this purpose than these brief addresses which gave specialists in one science clear notions of the things being done in other sciences. The evening address was by Professor E. E. Barnard, Yerkes Observatory, University of Chicago, upon "Some Late Results in Astronomical Photography," and was illustrated with lantern slides made from the most recent and most valuable astronomical photographs. As the lecture ended doubtless a good many members felt as one said: "There is no mind-stretcher equal to astronomy."

The academy has had several committees at work during the past year, among which are the following: on conservation, on legislation, on calendar reform, on leaflets on high school science, on pure and applied science in high schools, on ecological survey. All of these committees are continued so that they may make further report next year, but the report of the ecological survey committee, S. A. Forbes, chairman, should be especially mentioned. The districts actively investigated and made the basis of special reports, printed or to be printed, are: the Chicago area; the Beach area of northeastern Illinois; the county of Jo Daviess in the northwestern part of the state and Fulton County in the central part of the state; the sand prairies of the state; the Charleston area with extensions over the eastern Illinois; and the Illinois River, with extensions to the Mississippi and the Ohio rivers. A statistical survey of the bird life of the entire state, made four years ago, showing numbers, distribution and ecological relations of the species is now being prepared for publication. The ecological relations of the crawfishes of Illinois are being investigated by a special student. The work upon the animal life of the Chicago area is soon to be published by the Geographic Society of Chicago. While this is not a part of the work of the academy, it has been done by one of its members, Dr. Shelford, and constitutes a part of the ecological work of the state. Dr. E. N. Transeau is publishing a report upon the algæ of eastern Illinois, a report which notes 245 species, 23 of which have not previously been collected in North America, almost all these new forms having been found in old prairie ponds. Mr. T. L. Hankinson reports a most interesting and careful study of the distribution of the fishes of Coles County, a county drained partly by the Wabash system and partly by the Kaskaskia system, thus offering peculiarly good opportunity for such a study.

The individual papers upon the program of the academy follow:

"A Celestial Sphere," an apparatus to be used in the study of descriptive astronomy, constructed and installed at the Chicago Academy of Science (illustrated), W. W. Atwood, Chicago Academy of Science.

"Chicago Academy of Science—An Educational Force in the Community" (illustrated), W. W. Atwood, Chicago Academy of Science.

"Annotated List of the Algæ of Eastern Illinois," presented in form of a summary, E. N. Transeau, Eastern State Normal School.

"The Sexton Creek Limestone in Illinois," T. E. Savage, University of Illinois.

"A Plea for the Organization of Local Natural History Societies," Ruth Marshall, Rockford College.

"A New Species of Marionina from Illinois," Frank Smith and Paul S. Welch, University of Illinois.

"A Black-crowned Night Heronry" (illustrated), Charles W. Finley, Western State Normal School.

"Reproduction by Layering in the Black Spruce," George D. Fuller, University of Chicago.

"Studies of Evaporation and Soil Moisture in the Prairie of Illinois," George D. Fuller and E. M. Harvey, University of Chicago.

"The Stratification of Humidity in the Forest," Wade McNutt, Highland Park High School, and J. R. Locke, Streator High School.

"The Distribution of the Fish in the Streams about Charleston, Illinois," T. L. Hankinson, Eastern State Normal School.

"The Disappearance of the Beaver," Elliot R. Downing, University of Chicago.

"The Stratigraphy of the Chester Group in Southern Illinois," Stuart Weller, University of Chicago.

"Cloud Studies" (illustrated), M. L. Fuller, United States Weather Bureau, Peoria.

The new officers for the following year are:

President—F. W. Dewolf, State Geological Survey, Urbana.

Vice-president—H. S. Pepoon, Lake View High School, Chicago.

Treasurer—J. C. Hessler, James Millikin University, Decatur.

Secretary—E. N. Transeau, State Normal School, Charleston.

The academy has a membership of over four hundred, forty-five new members having been elected at the recent meeting.

Otis W. Caldwell,
Secretary

SOCIETIES AND ACADEMIES

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The fourteenth regular meeting of the society was held at the residence of Dr. Stiles, February 6, 1913, Dr. Stiles acting as host and Dr. Cobb as chairman.

Dr. Stiles presented a note on "The Value of Protozoa in Determining Fecal Contamination of Foods." *Entameba coli, Lamblia duodenalis* and *Trichomonas intestinalis* are obligate intestinal parasites having an easily recognizable spore stage. Any given case of infection is *prima facie* evidence of fecal contamination of food, and of insanitary surroundings. The indicator value of these protozoa, a thing which has been overlooked heretofore, is greater than that of *Bacillus coli*. In some parts of the south, infection with these protozoa will range from 10 to 60 per cent. of the persons examined.

Dr. Stiles presented a note by Stiles and Boatwright on "Subjective Symptoms of Thymol." The paper notes the results of 464 administrations of thymol to 244 patients, each patient receiving 1 to 7 treatments. Of the 464 administrations, 55.8 per cent. had no untoward effect; 44.2 had effects of some sort; 14 per cent. had nausea due to thymol or to Epsom salts; 13 per cent. had weakness due to thymol, Epsom salts or the lack of breakfast; 9 per cent. had a burning sensation referred to "the stomach," due to thymol; 9 per cent. had dizziness; 3 per cent. had headache; 2.8 per cent. had attacks of vomiting; 1.7 per cent. had a burning sensation in the throat; 1 per cent. had pain in the stomach; 1 per cent. complained of sleepiness. There was one case of dyspnea due to idiosyncrasy to thymol, and one of fainting due to idiosyncrasy to Epsom salts.

Mr. Crawley presented the following note on "Initial Stages of *Sarcocystis* Infection."

According to Erdman, the spore of *Sarcocystis muris* germinates in the intestine of the host and liberates a toxin, sarcocystin, which causes the adjacent digestive epithelium to be thrown off. The spore sets free an amebula which penetrates the denuded area and attains the lymph spaces of the submucosa, where it establishes itself and remains for 28 to 30 days.

My own observations indicate that the above account is far from correct. Feeding experiments carried on during the past few years show that the spore, under the form in which it occurs in the cysts, bores its way into the cylinder cells of the epithelium, occurring in some cells two or three hours after feeding, and there comes to rest. The spore changes in shape, becoming broadly elliptical or round, concomitant internal changes resulting in the production at the periphery of a row of masses of chromatin closely resembling stages in the schizogony of a coccidian. This point may be attained twelve hours after feeding. At the end of twenty-four hours the parasites appear to have abandoned the intestine.

According to my observations, the epithelial denudation mentioned by Erdman follows instead of preceding the invasion of the cells, a phenomenon well known as a sequel of heavy infections by other protozoan parasites.

Dr. Cobb presented some figures and specimens of free-living nematodes. Some marine forms have structures suggesting similar structures in insects and birds. One of them has a proboscis which might function in much the same way as analogous organs which in birds or insects are used for extracting food from flowers.

Dr. Cobb suggested that the clumsy term *lateral organ* be dropped as a descriptive term, since there are many other nematode organs which are also lateral. Since we do not know the true nature of this structure, he suggested the substitution of the new term *amphid*, which is compact, descriptive and yet non-committal as to function. For somewhat similar reasons he suggested that the *ventral gland* be called the *rennette*. Nematodes possess many other ventral glands. He has previously published a note on the urea content of this structure, thus justifying the functional implication carried by the diminutive rennette (*ren*, kidney).

The secretary presented a note by Dr. Albert Hassall, on "Nomenclatural Oddities." Certain rules of the code of zoological nomenclature are not observed by some writers, and some practises not contrary to the code are nevertheless undesirable from many standpoints. Disregard of the code and of good usage makes considerable trouble for the bibliographer, cataloguer and indexer. Common offences are: The casual introduction of unnecessary synonyms or the deliberate substitution of new names for old on grounds that never had recognition in the code; the proposal of new

names in footnotes, indices, figure labels or other out-of-the-way places; the habit of labeling a name *new species* in two or more publications; and the naming of new species by flocks of workers, so to speak, some specific names being referable to a chain of as many as five authors who have collaborated in the description.

By unanimous vote the society instructed the secretary to prepare a letter protesting against the proposed changes in the international code of zoological nomenclature which are being advocated by the German Zoological Society, and to submit the protest to the Ninth International Zoological Congress.

MAURICE C. HALL,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 466th regular meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., February 18, 1913, the president, Mr. George R. Stetson, in the chair.

Professor W. H. Holmes read a paper on "Agricultural Implements of the Mound-builders," saying:

The rich alluvial and prairie country of the middle Mississippi Valley is especially adapted to the practise of primitive agriculture and here are found large numbers of skillfully made flint blades of large size suitable for hafting as hoes and showing unmistakable evidence of long usage in operations that gave the working end a high degree of polish. They are made of grayish flint or chert which occurs plentifully in the form of flattish nodules in southern Illinois. These nodules were readily shaped by fracture with stone hammers, and vast numbers were gotten out and worked up by the mound-building tribes. The processes of manufacture were demonstrated by the speaker and it was shown with what ease and rapidity the blades could be made.

It was also shown by examples obtained from the Missouri River tribes that hoes made of the scapulæ of the buffalo were in use in very recent times and that the hoes found in excavating ancient sites near Omaha correspond with these recent Indian forms in shape, manner of hafting and surface polish, and that both display, although in bone, precisely the same kind of polish and markings as do the similarly shaped hoes of flint. It was suggested that these flint hoes were modeled after scapular hoes, since these were in general use by the tribes and have doubtless been in use from very early times among all the tribes advanced to the sedentary agricultural status of culture.

Referring to questions of antiquity which have been raised recently in regard to the burials of the Omaha district, it was suggested that since the buffalo was a comparatively recent arrival in the Mississippi Valley, a culture in which the bones of buffalo are represented must be younger, not older, than that of the mound-builders, since no traces or pictorial representations of the buffalo are found within the older Indian mounds.

This paper was briefly discussed. Mr. Stetson read notes on certain implements lately found in Britain. Professor Holmes commented concisely thereon.

Professor Holmes then read a paper on "Scope and Relationships of History and Archeology."

The second paper embodied in outline a study of the nature and scope of archeology and of archeological research as related to the field of human history as a whole. The history of man, or anthropology, according to Powell's classification, may be considered under seven heads or departments, giving rise to as many branches of research, as follows: somatology, psychology, philology, sociology, sophiology, technology and esthetology. In working out its problems each of these seven branches employs every available agency of research within and without its particular field and makes use of every form of record in which the history of man is embodied.

The records or sources of information to be drawn upon in these researches are comprised under two principal heads: intentional or purposeful records, on the one hand, and non-intentional or fortuitous records, on the other.

The intentional records are of four forms, as follows: (1) pictorial or pictographic; (2) commemorative, taking the form of monuments; (3) mnemonic, in the form of tradition and lore, orally transmitted; (4) inscribed or written records. Fortuitous records take numerous forms: (1) the diversified material results of human activities in which the commemorative motive is absent, but which comprise the great body of the products of handicraft; (2) the immaterial results of human activity as embodied in language, beliefs, customs, music, philosophy, etc.; (3) the ever-existing unpremeditated body of memories which accrue to each generation and are in part transmitted adventitiously; (4) the record em-

bodied in the physical constitution of man which when properly read tells the story of his development from lower forms; (5) the record of intellectual growth and powers to be sought and studied in the constitution of the mind; (6) the environments which reveal the story of the nurture and building up of the race throughout the past.

It is from these diversified records of present and past times that the story of the seven grand divisions of the history of man must be drawn. Archeology stands quite apart from this classification of the science, traversing in its own way the entire field of research. It claims for its own more especially that which is old or ancient in this vast body of data. It is even called upon to pick up the lost strands of the earlier written records, as with the shadowy beginnings of glyphic and phonetic writing, and restore them to the historian. It must recover the secrets of the commemorative monuments, the tombs and temples intended to immortalize the now long-forgotten great. It must follow back the obscure trails of tradition and substantiate or discredit the lore of the fathers. It must interpret the pictorial records inscribed by the ancients on rock faces and cavern walls which men meant should last forever. All that archeology retrieves from this wide field is restored to human knowledge and added to the volume of written history.

The services of archeologic science are equally potent in the field of the fortuitous records of humanity, for it reads that which was never intended to be read. The products of human handicraft, present and past, which have recorded automatically the doings of the ages are made to tell the story of the struggles, the triumphs and the defeats of humanity. The fortuitous records embodied in the non-material products of man's activities of to-day, although in themselves not antiquities, are made to cast a strong light on the history and significance of the material things of the past. Even the body of knowledge gathered from many sources and stored in the memory of the living, though unreliable and transient as a record, may be made to illumine the past; and the physical and psychical characters of man are in themselves records and may be made to tell the story of their own becoming and to explain the activities and the products of activity throughout the ages. All that archeology gathers from this wide field of research is added to the volume of written history.

In the great work of assembling the lost pages and completing the volume of the history of man, archeology may well claim first place among the contributing sciences.

This paper was discussed by Messrs. Casanowicz, Carroll, Stetson, Babcock, Hewitt, Swanton and Neumann.

A SPECIAL meeting of the Anthropological Society of Washington was held March 6, 1913, at 4:30 P.M., in the auditorium of the new building of the National Museum, the president, Mr. George R. Stetson, in the chair.

Dr. Walter Hough read a paper on "Savage Mutilations for Decoration."

The paper was a short excursion into the enormous field of custom with regard to ethnic mutilations, and sufficient examples were given to lay the subject rather completely before the society. In it were described the most striking forms of head shaping by pressure in infancy; the various forms of teeth mutilations; ear, nose, cheek and lip modifications and ornaments; pressure and mutilations in the arms, waist and limbs, and modifications of the bones of the feet. With mutilations also should be considered, perhaps, extraordinary hair dressing and treatment of the finger nails.

Many slides were shown of tattooing, scarification and decoration of the skin by means of dyes and pigments, and some of their multifarious meanings given. On the whole, it was concluded that ethnic mutilations originated from many concepts, the more important being a desire for identification, in some cases individual, but in most cases tribal; a desire for ornamentation, mainly individual in its treatment, but following environmental and tribal fashions; and also very important mutilations growing out of superstitious and religious ideas.

Many ethnic mutilations also relate to sex, puberty, social rank, honor for warlike feats and the like. All these ideas, which at times have been advanced as the explanation of the causes, show that the matter is extremely complex. The bearing of ethnic mutilations on primitive surgery was also hinted at, as well as its effects on the development of costume.

Dr. Williams and Dr. Swanton made certain inquiries and brief appurtenant remarks, which Dr. Hough answered.

WM. H. BABCOCK,
Secretary